Technical Report GL-95-19
October 1995

US Army Corps
of Engineers
Waterways Experiment
Station

Geomorphic Evaluation of Fort Leonard Wood

by Paul E. Albertson, WES
Dennis Meinert, University of Missouri at Columbia
Grant Butler, USDA Soil Conservation Service

Prepared for U.S. Department of Defense

Technical Report GL-95-19
October 1995

Geomorphic Evaluation of Fort Leonard Wood

by Paul E. Albertson

U.S. Army Corps of Engineers
Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

Dennis Meinert

University of Missouri at Columbia
Columbia, MO 65203

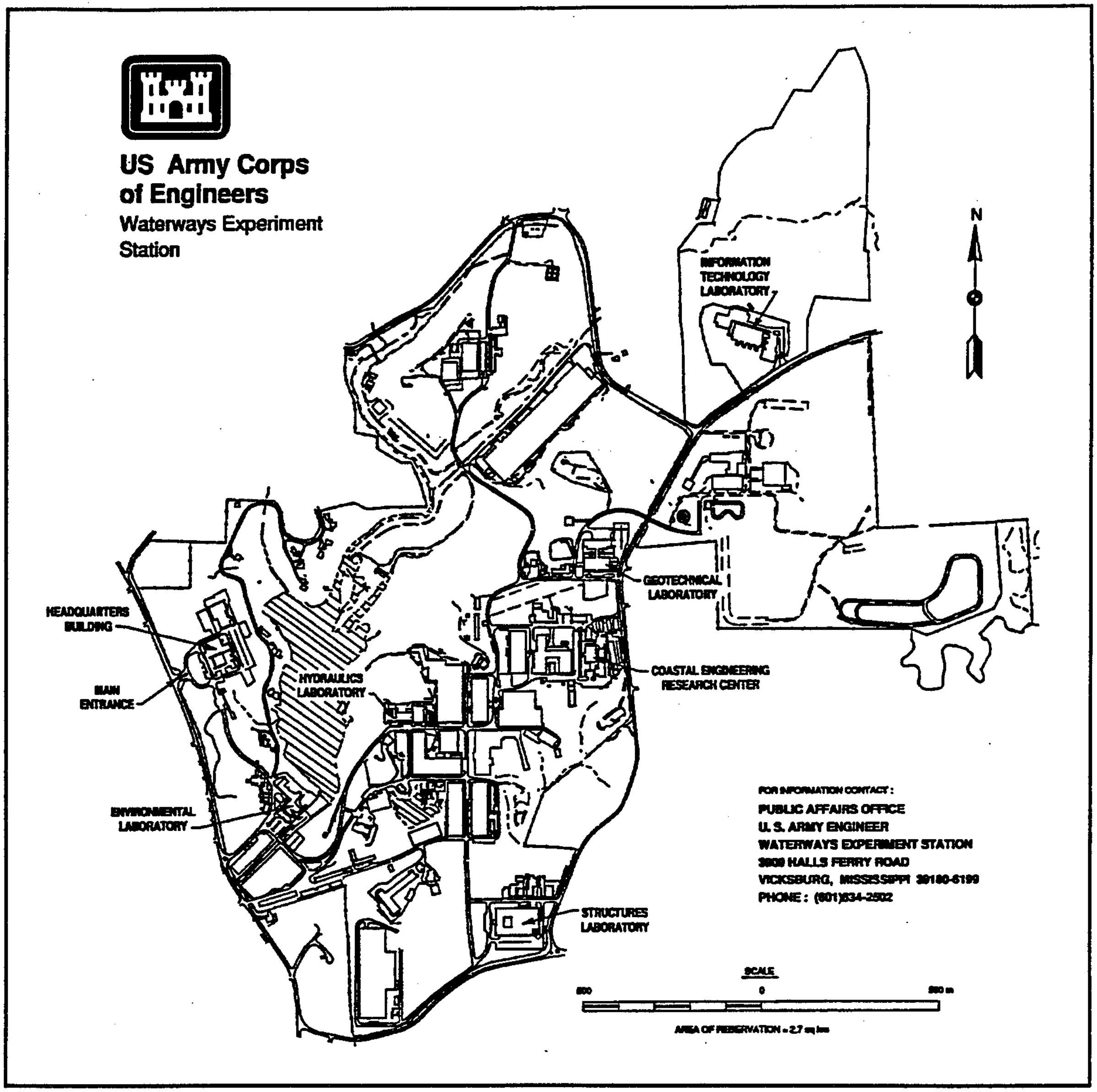
Grant Butler

Soil Conservation Service
U.S. Department of Agriculture
Columbia, MO 65203

Final report

Approved for public release; distribution is unlimited

Prepared for U.S. Department of Defense
Washington, DC



Waterways Experiment Station Cataloging-in-Publication Data

Albertson, Paul E.

Geomorphic evaluation of Fort Leonard Wood / by Paul E. Albertson, Dennis Meinert, Grant Butler ; prepared for U.S. Department of Defense.

380 p. : ill. ; 28 cm. — (Technical report ; GL-95-19)

Includes bibliographic references.

1. Cultural property, Protection of — Missouri — Fort Leonard Wood. 2. Geomorphology — Missouri — Fort Leonard Wood. 3. Archaeological surveying — Missouri — Fort Leonard Wood. I. Meinert, Dennis L. II. Butler, Grant. III. United States. Army. Corps of Engineers. IV. U.S. Army Engineer Waterways Experiment Station. V. Geotechnical Laboratory (U.S. Army Engineer Waterways Experiment Station) VI. United States. Dept. of Defense. VII. Title. VIII. Series: Technical report (U.S. Army Engineer Waterways Experiment Station) ; GL-95-19.

TA7 W34 no.GL-95-19

Contents

Preface ix

1—Introduction 1

Background and Study Area 1
Purpose and Scope 2

2—Soil Geomorphology Concepts 4

Geomorphic Surfaces and Soils 4
Introduction 4
Geomorphic surfaces 4
Allostratigraphic units 5
Geomorphic Processes 5
General 5
Lateral accretion 6
Vertical accretion 7
Terrace 7
Soils 8
Soil forming factors 8
Climate 9
Organisms 9
Topography 10
Parent material 10
Time 10

3—Previous Works 11

Regional Related Studies 11
Site Specific Studies 14
Site Specific Archaeological Studies 15
Summary of Previous Studies 16

4—Physical Setting 18

Geologic Setting 18
Geologic Units 19
Jefferson City dolomite 19
Roubidoux formation 19
Gasconade Dolomite Formation 22
Alluvium 22
Colluvium 23

Residuum 23
Climate 23

5—Geomorphic Investigation 25

Field Studies 25
Objectives and approach 25
Soil sampling 25
Field mapping 26
Laboratory Analyses 26
Radiocarbon dating 27
Biostratigraphy 27

6—Soil Geomorphic Units 28

Introduction 28
Objectives 28
Allostratigraphic units 28
Alloformations 32
T0-Cooksville formation 32
T1-Happy Hollow 32
T1-Allomembers 33
T2-Ramsey formation 33
T2-Allomembers 33
T3-Dundas formation 36
T3-Allomembers 36
T4-Quesenberry formation 36
T4-Allomembers 38
T5-Miller formation 38
T5-Allomembers 38
T6- Ousley Spring formation 41
T6-Allomembers 41
T7 Stone Mill formation 45
T7-Allomembers 45
T7co- Laughlin unit 47
AF-McCann formation 47
TR1-Baldridge formation 49
TR2-Hanna formation 49
Miscellaneous Units 52
B-Borrow areas 52
C-Construction areas 52
CO-Colluvial wedge area 52
E-Escarpment W/WO bedrock 52

7—Site Investigations 53

Objective and Approach 53
Typical Transects 55
Big Piney Happy Hollow 55
Lower Roubidoux 65
Upper Roubidoux 75

8—Soil Geomorphology and Cultural Resource Significance 89

Introduction 89
Objectives 89
Alloformations and archaeological significance 89
T0-Cooksville formation 89
T1-Happy Hollow formation 90
T2-Ramsey formation 93
T3-Dundas formation 94
T4-Quesenberry formation 94
T5-Miller formation 94
T6-Ousley Spring formation 95
T7-Stone Mill formation 95
T7co-Laughlin unit 96
AF-McCann formation 96
TR1-Baldridge formation 96
TR2-Hanna formation 97
Miscellaneous Units 97
B-Borrow areas 97
C-Construction areas 97
CO-Colluvial wedge area 97
E-Escarpment W/WO bedrock 98
Prediction of Site Occurrence 98
Site Preservation and Destruction 99
Introduction 99
Fluvial sedimentation and site preservation 99
Discussion 100

9—Summary and Conclusions 101

References 103

Appendix A: Soil Boring Logs A1

Appendix B: Soil Laboratory Data B1

Appendix C: Radiocarbon Test Results C1

Appendix D: Pollen Analysis D1

Soil Geomorphic Cross Section Plates

Soil Geomorphic Map Plates in Envelope in Back

List of Figures

Figure 1. Location map of Fort Leonard Wood 2

Figure 2. Regional physiography 18

Figure 3. Geologic map of Fort Leonard Wood 20

Figure 4. Generalized column section (Green and O'Mallary 1982) . . 21

Figure 5. Mean monthly temperature and precipitation (Green and O'Mara 1982) 24

Figure 6. Location of field studies 31
Figure 7. Typical T1 Happy Hollow allostratigraphy 34
Figure 8. Typical T2 Ramsey allostratigraphy 35
Figure 9. Typical T3 Dundas allostratigraphy 37
Figure 10. Typical T4 Quesenberry allostratigraphy 39
Figure 11. Typical T5 Miller allostratigraphy 40
Figure 12. Typical T5w Miller, wet allostratigraphy 42
Figure 13. Typical T5o Miller, organic allostratigraphy 43
Figure 14. Typical T6 Ousley Spring allostratigraphy 44
Figure 15. Typical T7 Stone Mill allostratigraphy 46
Figure 16. Typical T7co Laughlin stratigraphy 48
Figure 17. Typical TR1 Baldridge stratigraphy 50
Figure 18. Typical TR2 Hanna stratigraphy 51
Figure 19. Guide to compare USCS and USDA soil types 54
Figure 20. Location map for the Big Piney River at Happy Hollow site 56
Figure 21. Valley cross section for the Big Piney at Happy Hollow site 57
Figure 22. Location map of borings and trenches for the Big Piney at Happy Hollow site 58
Figure 23. Borings and trenches transect data for the Big Piney at Happy Hollow site 59
Figure 24. Interpreted section of the Big Piney at Happy Hollow 60
Figure 25. Trench HH T1 for the Big Piney at Happy Hollow site. . . . 61
Figure 26. Trench HH T2 for the Big Piney at Happy Hollow site. . . . 62
Figure 27. Trench HH T3 for the Big Piney at Happy Hollow site. . . . 63
Figure 28. Location map of the Lower Roubidoux. 66
Figure 29. Valley cross-section of the Lower Roubidoux near Cedar Hill Cemetery 67
Figure 30. Location map for Lower Roubidoux transect of borings and trenches 68
Figure 31. Location of Lower Roubidoux transect of borings and trenches data 69
Figure 32. Location of Lower Roubidoux transect of borings and trenches data 70

Figure 33. Interpreted section of Lower Roubidoux transect of borings and trenches data 71

Figure 34. Interpreted section of Lower Roubidoux transect of borings and trenches data 72

Figure 35. Trench LR-T1 of the Lower Roubidoux 73

Figure 36. Trench LR-T2 of the Lower Roubidoux 74

Figure 37. Trench LR-T4 of the Lower Roubidoux 76

Figure 38. Location map of Upper Roubidoux study area 77

Figure 39. Location map of Upper Lower Roubidoux transect of borings and trenches 78

Figure 40. Transect of boring and trench data on the Upper Roubidoux 79

Figure 41. Interpreted section of Upper Roubidoux 80

Figure 42. Trench UR-T1 81

Figure 43. Trench UR-T2 82

Figure 44. Trench UR-T3 83

Figure 45. Trench UR-T4 84

Figure 46. Trench UR-T5 85

Figure 47. Trench UR-T6 86

List of Tables

Table 1. Formations Ages of the Alloformations Used in This Study, and Their Relationship to Brackenridge (1981) and Haynes (1976, 1985) 13

Table 2. Alloformations Used in This Study and Their Relationship to (Wolfe 1989) Pulaski Co. Soil Survey Map Units 17

Table 3. Formation Symbols and Names, Sediment Type, Soil Horizons and Geomorphic Position 29

Table 4. Formation Names, and Related Soil Series 30

Table 5. Radiocarbon Dates as Related to Alloformation This Study 90

Table 6. Formations and Ages, Relationship to Brackenridge (1981) 91

Table 7. Archeological Site Potential of Alloformation at Fort Leonard Wood 92

Table 8. Relationship Between North America Archaeological Periods and Age Ranges of Alloformation at Fort Leonard Wood 93

Preface

The Geomorphological Study of Fort Leonard Wood is Legacy Resources Management Program cultural research demonstration project No. 430. The U.S. Army Engineer Waterways Experiment Station (WES) was authorized to conduct this investigation by the U.S. Army Construction Engineering Research Laboratory on DD Form 448, No. E5293C044, dated 18 November 1992, and by the U.S. Army Center for Public Works on DD Form 448, MIPR No. E87930426, dated 29 July 1993. Mr. Richard Edging, Fort Leonard Wood Cultural Resources Manager (ATZT-DPW-EE), was the program manager for this study.

The Legacy partners were numerous and are as follows:
Dr. Robert B. Jacobson, U.S. Geological Survey (USGS), Rolla, Missouri
Mr. Robert Wertheimer, Carleton College, Northfield, Minnesota
Ms. Rose McKenney, Pennsylvania State University/(USGS), Rolla, Missouri
Mr. Chris Vierrether, University of Missouri at Rolla, Missouri/(USGS)
Dr. David Hammer, University of Missouri at Columbia, Missouri
Mr. Dennis Meinert, University of Missouri at Columbia, Missouri
Mr. Grant Butler, Soil Conservation Service, Rolla, Missouri
Mr. Bruce Thompson, State Soil Scientist, Columbia, Missouri
Dr. Steven Ahler, University of Illinois, Champaign, Illinois
Dr. James Huber, University of Minnesota, Duluth, Minnesota
Mr. Brian Horning, Cadet, U.S. Army Military Academy
Mr. Todd David, Cadet, U.S. Army Military Academy
Mr. Richard Edging, Archaeologist, ATZT-DPW-EE
Mr. Curt Rankin, Forest Technician, ATZT-DPW-EE
Mr. David Jones, GIS Analyst, ATZT-DPW-EE
Mr. Marvin Meyer, Chief, ATZT-DPW-EE
Mr. Lester Trigg, CADD technician, ATZT-CE
Mr. Wayne Reese, Backhoe Operator, Dixon, Missouri
Mr. Grady Holley, CADD technician, Information Management Systems (IMS), Vicksburg, Mississippi
Mr. Jan Jordan, Bore Log Data Manager, University of Southern Mississippi, Hattiesburg, Mississippi
Ms. Theresa Foster, Revisions, San Diego State University, San Diego, California
Mr. Daryl Cook, ISM, Vicksburg, MS

Dr. Jacobson's expertise from his regional Ozark Stream Geomorphic Study guided the field work and greatly enhanced this project. Dr. Hammer provided soil analysis and served as graduate advisor for Messrs. Meinert and Butler. The alluvial soil geomorphic mapping was performed by Messrs. Meinert and Butler. State Soil Scientist Bruce Thompson visited the site during field investigation and arranged for Mr. Butler to be detailed to the Fort Leonard Wood mapping phase. Dr. Ahler shared his archaeological expertise during the field work and report writing. Mr. Hubert performed the pollen analysis for paleoenvironmental determination.

Messrs. Edging, Jones, Meyers, and Trigg, Fort Leonard Wood, provided the installation information and logistical support which assured successful completion of the project. Mr. Reese provided the safe trenches to examine the soil stratigraphy and some down-to-earth wisdom while the other partners expounded soil geomorphic paradigms.

A general field reconnaissance of Fort Leonard Wood was conducted by Mr. Edging and the author during the period of 19 to 22 April 1993. During detailed field reconnaissance with Dr. Jacobson during the period of 18 to 21 May 1993, landscape sites were selected for sampling. The first phase of soil sampling of selected geomorphic environments was conducted during the period 12 to 24 July 1993 with Dr. Jacobson and his colleagues Wertheimer, McKenney, and Ahler. The second phase of site specific sampling was accomplished with the participation of Dr. Jacobson and his colleagues Vierrether, Hammer, Meinert, Butler, and Thompson during the period 19 to 28 October 1994. Additional field mapping was accomplished by Messrs. Butler and Meinert during the period of January through August 1994.

Both West Point cadets, Horning and David assisted in the preparation of geomorphic cross sections. Their assistance is appreciated.

This investigation was begun and the report prepared by Mr. Paul E. Albertson, Geological Environments Analysis Section (GEAS), Engineering Geology Branch (EGB), Earthquake Engineering and Geosciences Division (EEGD), Geotechnical Laboratory (GL), WES, during the period March 1993 to September 1994. Mr. Dale Barefoot, EBG, WES, and Mr. Holley, IMS, computer drafted the report illustrations. Ms. Foster assisted in revisions of the final report. Mr. Daryl Cook prepared and printed the soil-geomorphic map plates.

This investigation was performed under the direct supervision at WES of Mr. Robert Larson, Chief, GEAS, Dr. A. Gus Franklin, Chief, EEGD, and Dr. William F. Marcuson III, Director, GL.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander was COL Bruce K. Howard, EN.

1 Introduction

Background and Study Area

The comprehensive natural and cultural resources management requirements at U.S. Department of Defense installations resulted in the institution of the Legacy Resource Management Program (LRMP) in 1991. LRMP was designed to inventory and manage biological, cultural and earth resources. The present study was performed as a Legacy Demonstration Project to demonstrate that by systematically inventorying earth resources, specifically soil geomorphic landforms it is possible to establish the relationship between landforms and the potential for preservation of the archaeological record.

The study was conducted at Fort Leonard Wood, Missouri located in south-central Missouri (Figure 1). The fort is 120 miles (193 kilometers) southwest of St Louis and 73 miles (117 kilometers) northeast of Springfield. The military reservation covers 68,564 acres or approximately 107 square miles. The fort is situated primarily in Pulaski County with small portion along the south west boundary in Laclede and Texas Counties. The major focus of this investigation is the Big Piney River and Roubidoux Creek Valleys situated on the military installation.

As a Training and Doctrine Command (TRADOC) installation, Fort Leonard Wood is the steward of thousands of acres of land and the archaeological resources within its boundary. In order to comply with the National Historic Preservation Act (NHPA Section 106) and Archaeological Resources Protection Act (ARPA), Fort Leonard Wood has developed a pro-active approach to inventory its archaeological resources through archaeological survey and the testing of archaeological sites. As part of this strategy, the geomorphology project described below is designed to provide crucial information on soil formation, age of landforms and the potential for buried or altered landscapes. This data is essential in site detection and preservation. Ultimately, it is designed to provide baseline geomorphic data that will aid archaeological investigations in the appropriate subsurface methods that are the most cost-effective in finding sites in alluvial settings.

Figure 1. Location map of Fort Leonard Wood

Purpose and Scope

The purpose of this work is twofold: (1) to provide data that will assist Fort Leonard Wood in compliance with federal regulations regarding the inventory and protection of archaeological sites; and (2) establish a baseline from which methods can be developed that effectively find sites in alluvial settings. This investigation will provide a geomorphic framework for the cultural resource management of Fort Leonard Wood. Specific objectives of this investigation were:

a. Identify and map the soil geomorphic features or landforms in the study area at an appropriate scale (1:12,000).

b. Define the geomorphic processes that are active in the study area.

c. Reconstruct the geomorphic development of the study area.

d. Determine the significance of the geomorphic features in terms of potential for archaeological site preservation and buried sites.

The study was conducted in four phases. Phase 1 was a preliminary investigation involving a literature review and field reconnaissance of the project area. Phase 2 consisted of soil-geomorphic testing of selected areas representive of valley bottoms on the military reservation. Field investigations determined site specific stratigraphic, pedologic and chronological characteristics of the different soil-geomorphic units within the study area. Phase 3 built upon the first two phases by soil-geomorphic mapping on aerial photography and construction of valley cross-sections. Phase 4 consisted of synthesis, regional correlation, and report writing.

2 Soil Geomorphology Concepts

Geomorphic Surfaces and Soils

Introduction

Soil-geomorphology is concerned with the relationships between landform evolution and soil development. Geomorphology is the science of the earth's surface features: their character, origin, and evolution (Challinor 1961). It emphasizes the formational effects of geologic processes on similar portions of the earth's surface. Such geologic processes include the effects of water, wind, gravity, ice, and diastrophism. The character and evolution of any given surface is in turn affected by climate, stratigraphy, and time. Basic concepts used in soil geomorphological analyses are presented in this chapter.

Geomorphic surfaces

Surfaces formed through the interaction of the above processes are called geomorphic surfaces. By definition "a surface is a two-dimensional plane. It has width and length, but no thickness" (Daniels and Hammer 1992); "a part of the land's surface defined in space and time" (Ruhe 1969). These two concepts were combined for the present report into: a geomorphic surface is a two dimensional unit with length and width which is defined by time. Geomorphic surfaces consist of two types, erosional and depositional. By definition:

> "An erosional surface is one formed by erosion and can have several shapes. It may range from nearly level to nearly vertical. A depositional surface is uneroded. It retains the shape left by the processes that deposited the underlying sediment" (Daniels and Hammer 1992)."

Surfaces in the Roubidoux Creek and Big Piney watersheds consist of both erosional and depositional surfaces. Dating of erosional and depositional surfaces is important in predicting the probability of the occurrence of archaeological sites. Surfaces can be dated through the use of several different

laboratory analyses such as radiocarbon (Table 2 and Appendix C). These tests are dependent on the presence of datable materials which are not always recovered. In the absence of such datable material a relative age may be determined by using the laws of superposition and ascendency and descendency, which are defined below.

The law of superposition states that in undeformed areas younger beds overlie older beds. The ascendency and descendency law states that; "a hillsope is the same age as the sediment to which it descends and a hillslope is younger than the hillslope to which it ascends" (Daniels and Hammer 1992). Both these laws in conjunction with laboratory analysis of datable carbon were used to date surfaces in this report. Relative dating supported with radiocarbon dates of five of the eight surfaces indicate that the lowest surface mapped, TO is the youngest and the highest T7 is the oldest. However, in any given reach of the Roubidoux and/or Big Piney not all of the soil geomorphic units or alloformations are always present. The surfaces are differentiated according to their physical characteristics, their apparent age, and by the types of processes that are active on each of these surfaces.

Allostratigraphic units

Allostratigraphic units were chosen to represent the divisions of the alluvium and colluvium for archaeological management on Roubidoux Creek and Big Piney River. An allostratigraphic unit is a mappable stratiform body of sedimentary rock that is defined and identified on the basis of its bounding discontinuities (North American Commission on Stratigraphic Nomenclature 1983). The upper boundary is determined by a geomorphic surface as defined previously.

Utilizing geomorphic surfaces and adding lithology produces a "three dimensional body of related lithofacies" (Autin 1991) associated with temporal equivalence and defines the fundamental unit used in this investigation, the alloformation. Separations in alloformations were based on differences in lithology, drainage, surface color, and geomorphic position. Divisions related to these characteristics represent allomembers, "a formal allostratigraphic unit ranked below an alloformation" (North American Commission on Stratigraphic Nomenclature 1983).

Geomorphic Processes

General

The following discussion on lateral and vertical accretion are based on large river models such as the Mississippi. The processes are presented as background for the non-geomorphologist using this report. The streams of the Ozarks which are smaller and higher energy, do not completely fit large river

models. For example Ozark point bars are extremely irregular and do not always have ridge and swale topography.

Lateral accretion

River channels migrate across their floodplain by eroding the outside or concave bank and depositing a sand or gravel bar on the inside or convex bank. With time, the convex bar grows in size and the point bar is developed. *Point bar* deposits are lateral accretion deposits formed as a river migrates across its floodplain. Associated with the point bar are a series of arcuate ridges and swales. The ridges are formed by lateral channel movement and are relic sandy lateral bars separated by low-lying swales. The swales are locations where fine-grained sediments accumulate.

Point bar deposits fine upward from the maximum size of the river's bed load (coarse sand and/or gravel) to fine-grained sediments (silt and clay) at the surface. The basal or coarse-grained portion of the point bar sequence (i.e., substratum) is deposited primarily by lateral accretion while the fine-grained or upper portion of the point bar sequence (i.e., topstratum) is deposited by overbank vertical accretion. The mechanics and resultant stratigraphy of lateral accretion of point bars is significantly modified in streams where high energy avulsion is common.

An abandoned course forms when the river's flow path is diverted to a new position on the river's floodplain. This event usually is a gradual process and begins by a break or a "crevasse" in the river's natural levee during flood stage. The crevasse forms a temporary channel that may, over time, develop into a more permanent channel. Eventually, the new channel diverts the majority of flow and the old channel progressively fills. Final abandonment begins as coarse sediment fills the abandoned channel segment immediately down stream from the point of diversion. Complete filling of the abandoned course is a slow process that occurs first by lateral accretion and then later by overbank deposition and vertical accretion. The complete filling process may take several hundred to several thousand years to complete. In some instances, complete filling may not occur as relict and upland drainage preserves partial stream flow through the course.

Abandoned channels are relict channel meanders that are abandoned when the river cuts across its point bar. The cutoff produces an abandoned meander loop or slough. The process by which the river abandons the loop occurs either gradually as a neck cutoff or during a single flood event as a chute cutoff. A chute is a high water channel across the point bar of the channel. Abandoned channels mapped by this study may be either well defined classic "oxbow" loops or loop segments. Abandoned channels or sloughs are abundant throughout the project area and were mapped by adding an "s" designation to the alloformations.

Channel filling is a gradual process. It occurs initially by lateral accretion, when the channel is still connected to the main course. After the main

channel has migrated away from the abandoned segment, then vertical accretion dominates. During times of high water flow, suspended sediment is transported to the abandoned channel. Abandoned channels that are not filled continue to receive sediment by overbank deposition during the peak flood season which may occur for only a brief time each year.

Vertical accretion

Vertical accretion deposits form by periodic flooding and vertical accretion of new sediment. Pedogenesis and bioturbation combine to form a characteristic soil profile. *Natural levee* deposits form by vertical accretion when the river overtops its banks during flood stage and sediment suspended in the flood flow is deposited immediately adjacent to the channel. The resulting landform is a low, wedge-shaped ridge with the greatest thickness adjacent to the river. Natural levee thickness decreases away from the river until it eventually merges with other floodplain deposits. Natural levee deposits were not mapped as a separate environment on the geomorphic maps in this report because this environment is present throughout the floodplain to some extent and mapping this environment is not possible at the scale of the present report. However, natural levee deposits are described in this report as a separate environment because it is an important geomorphic process in the study area, especially as it affects cultural resources.

Terrace

A *terrace* is an abandoned floodplain surface that is now elevated above the present river's floodplain and therefore is flooded less frequently than the floodplain. A terrace consists of a relatively flat or gently inclined surface that is bounded on one edge by a steeper descending slope and on the other edge by a steeper ascending slope (Bates and Jackson 1980). Terraces generally border the present floodplain or may be preserved as topographic islands or remnants within the present floodplain. Terrace islands or remnants in the floodplain were mapped because of the accuracy of the topographic data. Terraces are differentiated on the geomorphic maps according to their interpreted age, lithology, geomorphic position, and degree of pedogenesis.

In general, the boundary between the terrace and the floodplain was mapped by first defining the limits of the floodplain from hydrologic characteristics. This boundary was then further refined by incorporating soils data, land use as interpreted from aerial photography, and from site investigations conducted in the field.

In addition to flood frequency, another important characteristic that distinguishes terrace surfaces from the floodplain is the degree of soil profile development by pedogenic processes. The extent of soil genesis of a soil profile reflects the type and intensity of geomorphic processes that are active in the area and the relative age of the pedogenic surface. Soil forming processes are governed by the physical properties of the parent material, the environmental

influences of the geomorphic system, and the duration of the geomorphic processes. A stratified and weakly developed soil profile indicates that the soil has been recently deposited and has not had sufficient time to develop a pedogenic imprint.

Soils

A definite relationship was established during the study between geomorphic surfaces and soil materials. The relationship was found to be consistent from the southern to northern reaches of the stream. This consistency increases the ability to predict location and probability of archaeological sites and pattern of soil genesis on a given surface.

Soil genesis on each surface "can be viewed as consisting of two steps: (a) the accumulation of parent materials, and (b) the differentiation of horizons in the profile" (Simonson 1959). The primary parent material in this study is alluvium with loess, colluvium and hillslope sediments being secondary sources. Horizon differentiation in the parent material is a result of four basic processes occurring throughout the system. These are additions, removals, transfers, and transformation (Simonson 1959). These changes are brought about by the effects of the soil forming factors: climate, organisms, topography, parent material, and time.

Soil forming factors

The five soil forming factors have been studied both independently and in combination for over 100 years. These studies have shown that "the balance among individual processes in a given combination becomes the key to the nature of a soil" (Simonson 1959). These factors have been put fourth in equation form:

$$s = f\,(cl,\ o,\ r,\ p,\ t\ldots) \tag{1}$$

where s denotes any soil property. The soil-forming factors in parentheses, actually represent "groups of factors, and are defined as follows:

cl = climate

o = organisms and their frequencies referring to species germules rather than actual growth

r = relief or topography, also including certain hydrologic features (e.g., water table)

p = parent material, defined as state of sediment at soil formation time zero

t = age of soil, absolute period of soil formation

... = additional, unspecified factors" (Jenny 1961)

A discussion of each of the factors follows.

Climate

The climatic factor is considered by many to be the most important factor in the development of soil characteristics. It accounts for the present and historical effects of precipitation, temperature, and wind on soil features. These influences are in turn modified by aspect, altitude, and the other factors.

Precipitation is important because water is involved in most of the physical, chemical and biochemical processes that go on in a soil, and the amount of moisture delivered to the soil surface influences the weathering and leaching conditions with depth in the soil (Buol et al. 1978). Solar radiation has an impact on the amounts of moisture reaching the soil surface and the rates of chemical and biochemical processes. Combined they effect the abundance and composition of vegetation. Wind is an important agent effecting the transport and distribution of suspended material (dust and aerosols) over large distances.

A significant point in considering the effect of climate is its cyclic nature, and variance in time and amounts of inputs. Soil features are thought of as an accumulation of climatic inputs over time, but "often it is not the mean climatic conditions which are relevant, but the less frequent more extreme ones which may control specific features of the soil or landscape" (Yaalon 1983).

Organisms

The organism factor is comprised of the fauna and flora of a particular region. Each component within these groups has a specific set of functions it performs in the ecosystem. Through these functions the entire biota, from microscopic bacteria and protozoa to large trees and burrowing animals, influence the development of soil properties. As with climate both the past and present influences of plants and animals is visible in the present soil.

Plants are involved in the initial development of soils through mechanical and chemical weathering. Throughout the succession of soil development the properties of organic carbon, nitrogen, pH, bulk density, color, and structure are effected by plants. Species differ in the ability to impact these properties because of the variability in recycling nutrients, supplying organic matter, producing leachates and rooting patterns. For example, forested sites commonly show greater leaching of cations, lower pHs, greater clay translocation and lower organic matter when compared to grasslands.

The influence of animals populations on the development of soils has not been given the emphasis that vegetation has. Even though the importance of microbial and visible animal populations can be seen in the decomposition of

organic matter, the additions they make to humus development and the mixing brought about by the activities of burrowing species is commonly overlooked. Grazing species and even man impact the soil. Ungulates influence the soil through plant selection and compaction, while man does so through cultivation and compaction.

Topography

Topography refers to the surface shape of a landform. It includes the relief, gradient, length and width, slope orientation, and shape such as convexity or concavity. It effects soil hydrology, runoff or run-on, erosion or deposition, and in conjunction with climate, vegetation. These attributes govern soil properties such as clay distribution, depth of weathering, profile development, organic matter content, and chemical composition and distribution.

Parent material

Parent material refers to unconsolidated organic and mineral materials in which soils form (Soil Survey Staff 1993). It is the material present when soil genesis is initiated. The following classes of parent materials are recognized: residuum - materials produced by weathering of rock in place (i.e., dolomites, sandstones, granites, etc.); alluvium - materials moved and deposited by water; loess, and aeolian sand materials moved by wind; or colluvium - materials moved by gravity. These materials can occur singularly or in combination, e.g., colluvium over residuum or loess over colluvium and residuum.

The nature and original properties of the parent material are important to the development of soil properties. It determines many of the chemical, mineralogical and physical properties of a soil. It influences types of clay developed, structure, texture, color, and natural fertility. These properties in turn influence drainage, available moisture, and vegetation.

Time

"Time here refers to passage of time . . . and in itself has no influence on the landscape; rather it records the accomplishments of the system" (Schumm 1977). Time in the above context is important only to help establish a starting and stopping point and to compute process rate (Daniels and Hammer 1992). Weathering of the parent material and development of soil features are aligned with time. Diverse parent materials will vary in the amount of time needed to produce soil material. Soil features will vary in the amount of time needed for development. Determining these times for a given parent material or feature can in some cases assist in ascertaining relative age.

3 Previous Works

Regional Related Studies

River Valleys of the Ozark Plateau by Hersey (1895) is one of the earliest scientific descriptions of the region. He noted the rivers of the Ozarks had a characteristic duplex nature, i.e. a small trough cut into the larger valley. The incision formed strata terraces which early settlers referred to as "bench-lands." Hersey believed that the level and formation of the terrace have nothing to do with the hardness of the rock formation. He noted river gravel on top of the high terraces. Hersey hypothesized a concept of three episodes of uplift and incision forming the valleys. His model is Davisian in nature and describes the evolution of the Ozark Plateau and valleys in a much broader time and space scale than the present study's focus. There is no independent data corroborating evidence to support Hersey's idea that terraces are due to uplift.

The Large Springs of Missouri by Beckman and Hinchey (1944) provided a detailed inventory of the location, description and estimated flows of major springs. There are numerous large springs in Pulaski County, such as Miller Spring, Roubidoux Spring, and Stone Mill Spring. Miller Spring flows from the Gasconade Dolomite into the Big Piney south of the military installation. Roubidoux Springs is located in Waynesville and flows into the Roubidoux Creek north of the fort. Stone Mill Spring is located on the fort property (sec 21, T35N, R10W) and it issues from the a rock ledge in the Gasconade Formation. Beckman and Hinchey (1944) report flows between 10 and 15 million gal per day from Stone Mill Spring.

The Geomorphic History of the Ozarks by Bretz (1965) presented a model of the Ozark uplift and subsequent erosion to produce dissected peneplains, monadnocks, and steep valleys. He opposed ideas of cyclic pedimentation and noncyclic dynamic equilibrium. Bretz advocated a succession of three episodes of alternating uplift and erosion. He noted strath terraces which were independent of stratigraphic control. Bretz specifically refers to the Big Piney-Roubidoux divide as an elongated dividing upland which is dissected by encroaching tributaries. He notes the broadening of the flat upland at Fort Leonard Wood near the north end of the divide (Waynesville Quadrangle, Pulaski County) which has several 1,100 ft summits. Bretz's work continues

Herseys' (1895) ideas of former peneplains with alluvial gravel and episodes of uplift and erosion. To date, these hypotheses are untested.

Sedimentary Processes at Rodgers Shelter by Ahler (1976) described in detail the chemical and physical properties of strata in one terrace (T1-b) on the Pomme de Terre River at Rodgers Shelter. The analysis distinguished the likely sedimentary process of each strata. He differentiated colluvial, alluvial, and aeolian deposition.

Haynes (1976) described the *Late Quaternary Geology of the Pomme de Terre Valley*. He presented the following geochronology the last 38,000 years. Aggradation occurred from 38,000-30,000 years B.P. For degradation occurred between 30,000-28,000 years B.P. followed by stability between 26,000-23,000 years B.P. Slow aggradation followed and continued to about 16,500 years B.P. Downcutting occurred sometime after 13,000 but before 11,000 years B.P. The river began to aggrade again by 10,500 as Paleo-Indians entered the region. Aggradation continued to about 6,000 years B.P. followed by 4,000 years of stability with minor colluvial and overbank deposition. Before 1,000 years B.P. the flood plain was abandoned. Another erosion and deposition episode occurred between 600 and 400 years B.P.

Brackenridge's (1981) studies of *Late Quaternary Floodplain Sedimentation Along the Pomme de Terre River* noted river degradation at about 32,000, 13,000, 7,800, 5,000 2,900, 1,700, and 350 years B.P. He recognized six mappable units and distinguished two types of contacts. Along the river, cut and fill produced younger insets, while in an abandoned channel younger units were overlapping older units as drapes. Two aeolian episodes were interpreted as occurring during the Wisconsin and early Holocene. He concluded that terrace formation may be the direct impact of climatic change rather than glacial or sealevel change. For example, erosion was a response to "little ice age" and the resulting increase in stream power instead of drought. He attributed gaps in the Holocene stratigraphic record to periods of erosion caused by frequent large floods while depositional periods occurred during periods of stability and small floods. Table 1 relates Brackenridge (1981) and Haynes (1976, 1985) formation names to the present study.

Johnson's (1981) *Soil Geomorphology of the Lower Pomme de Terre River Valley, Missouri and Surrounding Area* presented soil genesis data corresponding to Haynes' (1976) geomorphic units. The study concluded that the Rodger's shelter alluvium is reworked Peorian Loess (late Wisconsin) and that the younger Pippins soil is also derived from reworked loess but has been humified and darkened. Landscape instability associated with the formation of the Rodger alluvium is associated with climatic change. However, the Pippins, which is charcoal rich, is proposed to be due to slash and burn technology of late Holocene Woodland Indians. The results of radiocarbon dating and pedologic analysis indicated that moderately to strongly developed alfisols could be formed in less than 3,600 years. In a subsequent study Johnson

Table 1
Formations Ages of the Alloformations Used in This Study, and Their Relationship to Brackenridge (1981) and Haynes (1976, 1985)

Formation	Age (year B.P.)	Relationship to Brackenridge's
T0 Cooksville	0-100	No related unit. Present day gravel and sand bars. Separated with stream. Bars in process of migrating downstream.
T1 Happy Hollow	0-300	Related to Pippens formation: T0b unit. Carbon dates 190 to 330 years B.P. Alluvial deposition on surface consisting of sand, gravel and cobbles.
T2 Ramsey	300-1,400	Related to Pippens formation: T0a unit. Carbon dates 430 to 840 years B.P. Alluvial deposition on surface consisting of sand and fine gravel.
T3 Dundas	2,000-3,000	Related to Rodgers formation: T1b4 unit. Carbon dates 1,680 to 2,360 years B.P. Alluvial deposition on surface consisting of silts and very fine sands.
T4 Quesenberry	3,400-4,000	Related to Rodgers formation: T1b3 unit. Carbon dates 3,610 to 4,585 years B.P. Some formations with alluvial deposition on surface.
T5 Miller	4,300-10,000	Related to Rogers formation: T1b1 and T1b2 units. Carbon dates 5,200 to 10,200 years B.P. No alluvial deposition on surface. Holocene deposits.
T6 Ousley Spring	10,000-55,000	Related to the Trolinger Spring and possibly Koch and Boney Springs formations: T-1a and T-2 units. Carbon dates 13,550 to >48,900 years B.P. Pleistocene deposits.
T7 Stone Mill	10,000-130,000	Related to Breshears formation: T3 unit. No carbon dates.
T7co Laughlin Unit	10,000->55,000	No related unit. Unit occurs in close proximity to alluvial soils. A variable unit consisting of colluvium, reworked loess, residuum, or a combination.
AF McCann	0-55,000	No related unit. Alluvial fans.
TR1 Baldridge	0-2,000	No related unit. Small tributaries.
TR2 Hanna	2,000-8,000	No related unit. Medium to large tributaries.

(1982) proposed a landscape model in which 50 cm of deposition has occurred in the valley since 2,000 years B.P.

Geomorphic Investigations, in Archaeological Investigations in the Ozark Scenic Riverways (Saucier 1981, 1983, 1984, 1987) reported on the soil and stratigraphic aspects of geomorphology in the Current River basin, to the

southeast of the Fort Leonard Wood area. Saucier (1987) differentiated the active floodplain into two sperate units (T0 and T1) with three adjacent terraces (T2, T3, and T4). Personnel communication with Saucier (1993) pointed out corresponding surfaces based on elevation are not always time correlative but rather a function of flood magnitudes.

Guccione (1991) summarized the preceding studies in an overview of the *Quaternary Nonglacial Geology of the Interior Highlands* which includes the Ozark Plateau. She highlighted the work of Bretz (1965) noting that the residuum is probably Tertiary in age. Two loess deposits are discussed, the older correlates to the Loveland which is considered to be Illinoisan and the younger correlates to the Peoria Loess. The colluvial process in the region has been operating throughout the Pleistocene into the Holocene. Some colluvium can be relatively dated based on overlying loess deposits. The Pomme de Terre studies (Haynes 1976; Brackenridge 1981) provided the framework to differentiate the alluvium. This recent review and compilation of previous works of the region provides a good framework for the present study of Fort Leonard Wood.

Thompson and Robertson's (1993) *Guidebook to the Geology Along Inter-State Highway 44 (I-44) in Missouri*, provides an overview and detailed descriptions of the rock outcrops along I-44 in the vicinity of Fort Leonard Wood. Studying the measured sections of roadcuts offers a way to differentiate the Gasconade and Roubidoux Formations.

Geomorphic Study in the Upper Gasconade River Basin, Laclede and Texas Counties, Missouri by Gamble (1993) investigated the upland geomorphic surfaces and noted that the erosion surface cut across geologic contact. In addition, he designated a valley surface as the Lambeth terrace. The occurrence of this terrace was recognized on the Osage Fork, the Gasconade, and the Big Piney Rivers. Gamble correlated his Lambeth terrace to Saucier's T4, Brackenridge's (1981) Trolinger Formation (T2), and Haynes' (1985) Trolinger Spring Formation. The significance is that the Trolinger is estimated to be 50,000 to 160,000 years B.P. (Brackenridge 1981 and Haynes 1985).

Site Specific Studies

The Soil Survey of Pulaski County by Wolf (1989), was used as a resource for initial concepts and comparison. The purpose of the soil survey is to supply predictions of soil behavior for a wide range of users (Wolf 1989). This report covered the area under study at a scale of 1:24,000 or 1 in. equal 2,000 ft. The survey's purpose and scale were two limiting factors for intensive geoarchaeological predictive purposes of the present geomorphic report.

Warren (1993) studied *Freshwater Mussels from Caves and Rockshelters at Fort Leonard Wood, Pulaski County, Missouri*. He interpreted the mussels found with archaeological remains to represent a subsistence resource from the

streams running throughout the fort. Warren (1993) suggests, "...that the gravelly stream beds that occur today along the Big Piney River and Roubidoux Creek are not recent products of historical land-clearing activities and subsequent erosion and redeposition of course sediment in the area. Rather, they appear to be the modern signature of a high energy stream type that exist thousands of years into the past." His mussel study suggested the Big Piney River and Roubidoux Creek have been gravel bed streams throughout the Holocene and thus were not significantly altered by historic land clearing.

Terrain Analysis Atlas (Greenhorne and O'Mara 1982) is a series of maps of the military installation at a scale of 1:50,000 and accompanying text which describes the military aspects of the terrain. Included in the atlas which pertains to this geomorphic investigation are: surface configuration, surface drainage, water resources, engineering soils, engineering geology, vegetation and climate. The analysis is very informative but general in scope. It is designed to assist planners make troop stationing decisions. It contains environmental data but is not intended for environmental impact assessment. Therefore for the purpose of the present study the terrain analysis serves as a general reconnaissance level framework to view the fort's geomorphology. The engineering geologic map was the source information for the GRASS data layer for geology. The engineering geology map of the fort at a scale of 1:50,000 separates the military reservation into 5 units which correlate to the Gasconade Formation (Fm), Roubidoux Fm, Jefferson City Fm, Colluvium, and Alluvium.

GRASS Database Fort Leonard Wood GIS data layers include: Soils, Topography, Elevation, Geology, Hydrology, Archaeological Sites, and Disturbed Areas on the fort. The geology layer is derived from the Terrain Analysis. The soil coverage is from the Pulaski County Soil Survey (Wolf 1989). The vegetation and disturbed areas is derived from a forest survey. The archaeological site records were compiled from hardcopy reports into a dBase 3 file and attached to the GRASS database.

Site Specific Archaeological Studies

Prehistory of the Gasconade Drainage by Robert Reeder (1988) is the most comprehensive archaeological research to date. This dissertation provides a useful synthesis of the Fort Leonard Wood regional culture history, settlement patterns, and subsistence data for the Gasconade drainage. Many of the sites used in the analysis are located in Pulaski County and Fort Leonard Wood. Reeder (1988:274-278) addressed two archaeologic-geomorphic models for the Gasconade basin which are applicable to this project. While Reeder's discussion is a summary it is a good starting point to test geomorphic models.

Phase I Archaeological Survey of Selected Areas At Fort Leonard Wood, Missouri by American Resources Group, Ltd. (March 1989) is a source of archaeological data which adequately met the basic phase I guidelines.

Phase I Archaeological Survey of Selected Tracts At Fort Leonard Wood, Missouri by Ahler and McDowell (1992) offers comprehensive results from four cultural areas on the military reservation. The report highlights the environmental setting describing the geology, soil, and climate. Following the reporting of the archaeological surveys, the authors related their work and previous work to a predictive model. They concluded that predictive modeling will require several iterations and testing, and must consider environmental landscape variables such as geology, geomorphology, and geochronology.

Summary of Previous Studies

The recent geomorphic studies conducted along major streams of the Salem Plateau have been used to support the present work along Roubidoux Creek and Big Piney River. Detailed work on the lithology, chronology, and morphology of valley fill from the lower Pomme de Terre River was conducted by Brackenridge (1981) and Haynes (1976, 1985) on the Rodger Shelter site. This site occurs northwest of the present work area. Johnson (1981) added the pedologic data to Brackenridge and Haynes' geomorphology needed for regional correlation to the present report's soil-geomorphic units. Another near-by study performed by Saucier (1987), presents similar types of data on the Current River, southeast of Fort Leonard Wood. These previous works and the present report show a high correlation between terrace levels. A geomorphic report of the upper Gasconade river by Gamble (1993) studied the upland geomorphic surfaces and in addition a surface designated as the Lambeth terrace. The occurrence of this terrace was recognized on the Osage Fork, the Gasconade, and the Big Piney Rivers. The present study area includes portions of the Big Piney Rivers and Roubidoux Creek, a tributary to the Gasconade. Two terraces, the Stone Mill Formation and the Ousley Springs, were delineated in this study and correspond to Gambel's Lambeth terrace. Correlating the present work to Brackenridge's (1981) and Haynes' (1985) nomenclature the Stone Mill Formation compares to the Breshears Valley Formation and the Ousley Springs to the Trolinger Springs Formations. Therefore, based on regional correlations the Stone Mill and Ousley Springs Formations are inferred to be Pleistocene age terraces. Table 1 presents the soil geomorphic formations and regional relations to Brackenridge (1981) and Haynes (1985) formations.

The Soil Survey of Pulaski County by Wolf (1989) was used as a resource for initial concepts and comparison. The valley bottoms of the Big Piney River and Roubidoux Creek are generally mapped as the Nolin-Huntington-Kickapoo association. The floodplain position of each follows: Nolin soils occur at higher elevations above the stream channel, Huntington in lower areas, and Kickapoo in low areas adjacent to the current channels of streams. Four other minor soil series are used to map the valleys. The Moniteau is a poorly drained soil mapped on terraces adjacent to the uplands. On alluvial fans along small streams entering the major flood plains the well to extensively drained Cedargap soil series is mapped. On footslopes, the Claiborne and Hartsville series are delineated. The soil-geomorphic units used in this

report have general relationship to the soil series as presented in Table 2, but due to difference in scale, detail, and intended use of the mapping, there is not a consistent relationship. In comparing the soil survey to the completed product of this report, one can see the level of detail lost at the 1:24,000 scale and the general nature of the placement of the map unit boundaries. These limitations decrease the value of utilizing the county scale soil survey for Cultural Resource Management and modeling on Fort Leonard Wood.

Table 2
Alloformations Used in This Study and Their Relationship to (Wolfe 1989) Pulaski Co. Soil Survey Map Units

SYM/Formation	Related Soil Survey Map Units
T0 Cooksville	River delineation and 38-Riverwash
T1 Happy Hollow	38-Riverwash and 30A-Kickapoo fine sandy loam, 0 to 3 percent slopes
T2 Ramsey	30A-Kickapoo fine sandy loam, 0 to 3 percent slopes
T3 Dundas	40-Huntington silt loam
T4 Quesenberry	29-Nolin silt loam and 31A-Razort silt loam, 0 to 3 percent slopes
T5 Miller	29-Nolin silt loam and 31A-Razort silt loam, 0 to 3 percent slopes
T5W Miller (Wet)	26-Moniteau silt loam
T6 Ousley Spring	37B-Hartville silt loam, 2 to 5 percent slopes
T7 Stone Mill	14C-Claiborne silt loam, 5 to 9 percent slopes 14B-Claiborne silt loam, 2 to 5 percent slopes (&37B-Roubidoux)
T7co Laughlin Unit	20C-Doniphan very cherty silt loam, 3 to 9 percent slopes 16C-Clarksville very cherty silt loam, 3 to 9 percent slopes 16D-Clarksville very cherty silt loam, 9 to 14 percent slopes 32C-Vibration silt loam, 3 to 9 percent slopes
AF McCann	12A-Cedargap cherty silt loam, 0 to 3 percent slopes (Variable and alluvial fans generally not mapped at 1:24,000 scale)
TR1 Baldridge	12A-Cedargap cherty silt loam, 0 to 3 percent slopes 30A-Kickapoo fine sandy loam, 0 to 3 percent slopes
TR2 Hanna	12A-Cedargap cherty silt loam, 0 to 3 percent slopes

4 Physical Setting

Geologic Setting

Fort Leonard Wood is located within the Salem Plateau portion of the Ozark Plateaus Province of the Interior Highlands (Figure 2). The bedrock underlying and outcropping on the military reservation consists of Ordovician age cherty dolomites and sandstones. The rock units dip regionally to the northwest at approximately 6 ft to the mile (1 m to the kilometer).

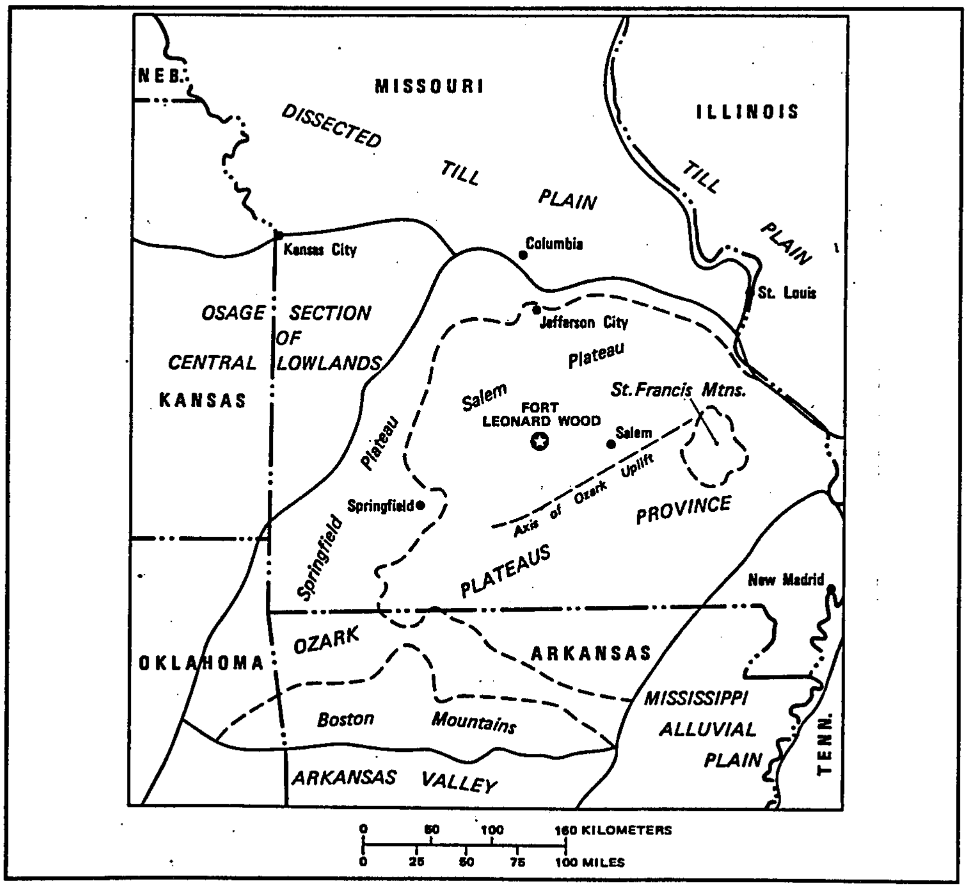


Figure 2. Regional physiography

Geologic Units

The rock units exposed on the fort consist of the Jefferson City, Roubidoux, and the Gasconade Dolomite Formations. The geologic map presented in Figure 3 displays a GRASS output of the geology coverage of the fort. A representative geological section of the bedrock on the fort is presented in Figure 4 (Greenhorne and O'Mara 1982). Differences in these formations. have traditionally been based upon the relative amounts of chert and sandstone, the type of dolomite, the type of chert, etc. (Thompson 1991).

Jefferson City dolomite

The Jefferson City covers approximately 17 percent of the reservation (Figure 3). This unit forms the dissected plateau at higher elevations. A considerable portion of this formation is represented by weathered clayey residuum. This is exposed in the south central portion of the reservation along Highway 1 from the southern boundary to approximately 1 mile (2 km) north of Bloodland. It is also found in the southwest part of the reservation. Limited exposures of dolomite occur on upland shoulders along the upper Roubidoux Creek and on higher elevations throughout the central and southern portions of the fort.

A light-brown to medium-brown, medium to finely crystalline dolomite dominates the Jefferson City Formation. Chert is locally abundant and is microcrystalline. A thickly-bedded, brown, medium crystalline dolomite, locally known as the "Quarry Ledge" occurs approximately 25 to 35 ft (7 to 10 m) above the Jefferson City-Roubidoux contact. It is a persistent bed up to 10 ft (3 m) thick. The lower 25 to 35 ft (7 to 10 m) consists of a light gray, fine grained argillaceous dolomite commonly referred to as "cotton rock," and sandy chert, oolitic chert and shale beds (Figure 4).

This formation is approximately 190 ft (58 m) thick and occupies the high summits and upper backslopes of tributaries. Elevations range from 1,130 to 1,320 ft. The contact between the Roubidoux Formation and the Jefferson City Formation is a siliceous oolitic, cherty dolomite below the base of the Quarry Ledge. This contact on the fort occurs at the approximate elevation of 1,130 ft (345 m).

Roubidoux formation

The Roubidoux Formation covers almost two thirds (64 percent) of the reservation (Figure 3), making it the predominant formation on the fort. The Roubidoux underlies the broad plateau in the northern portion of the fort, where the cantonment is situated. Along the valleys it forms the gentler upper slopes bordering the plateau. The formation outcrops along the upper backslopes of the northern Roubidoux Creek and the lower backslopes of the

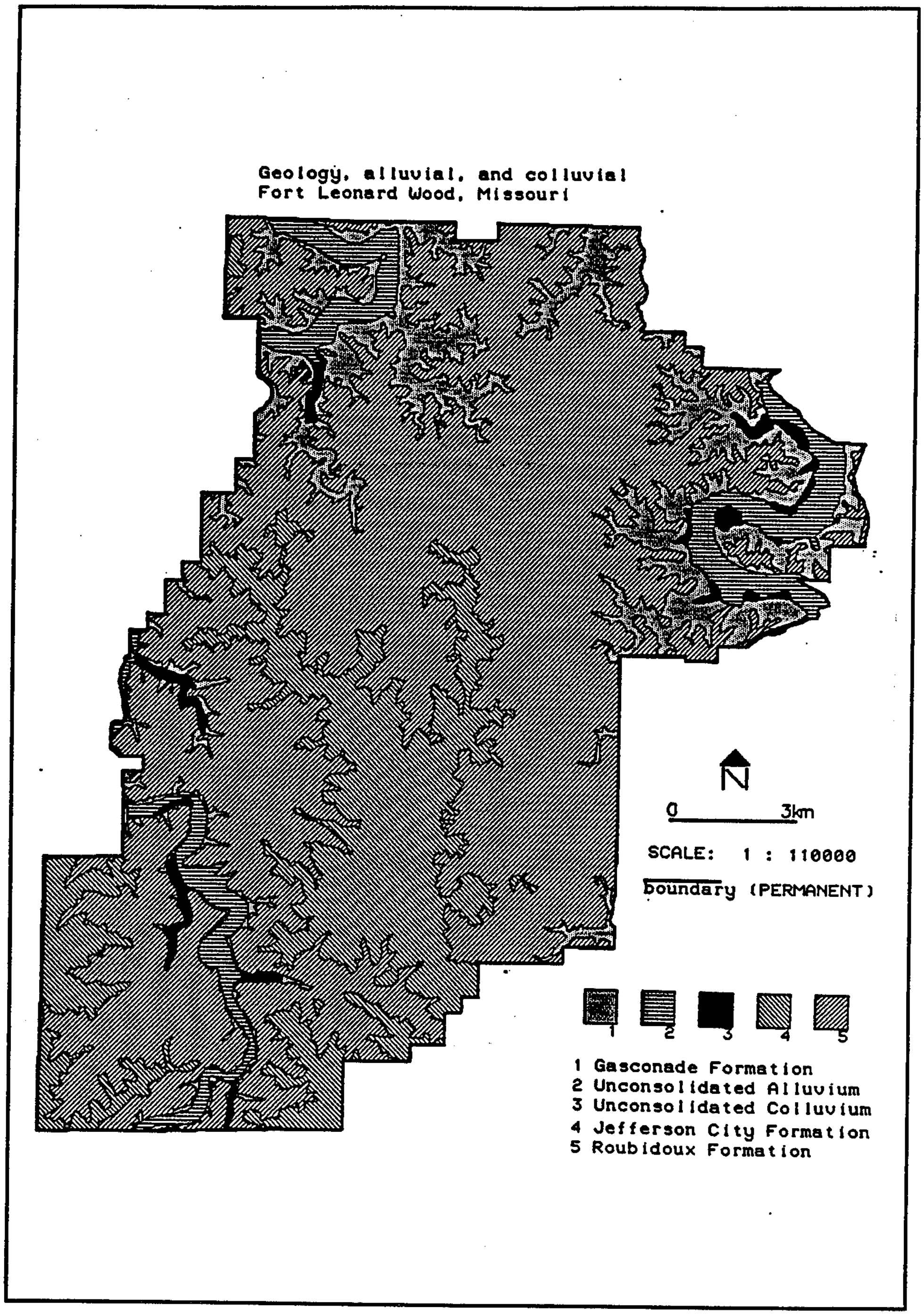


Figure 3. Geologic map of Fort Leonard Wood

central and southern portions of the drainage basin. In the southern part of the fort the Roubidoux Formation underlies the Jefferson City Formation. Where overlain by the Jefferson City Formation it forms steeper slopes.

Lithologically, the Roubidoux Formation is highly variable, both vertically and laterally. It is composed of interbedded dolomite, quartz sandstone, and

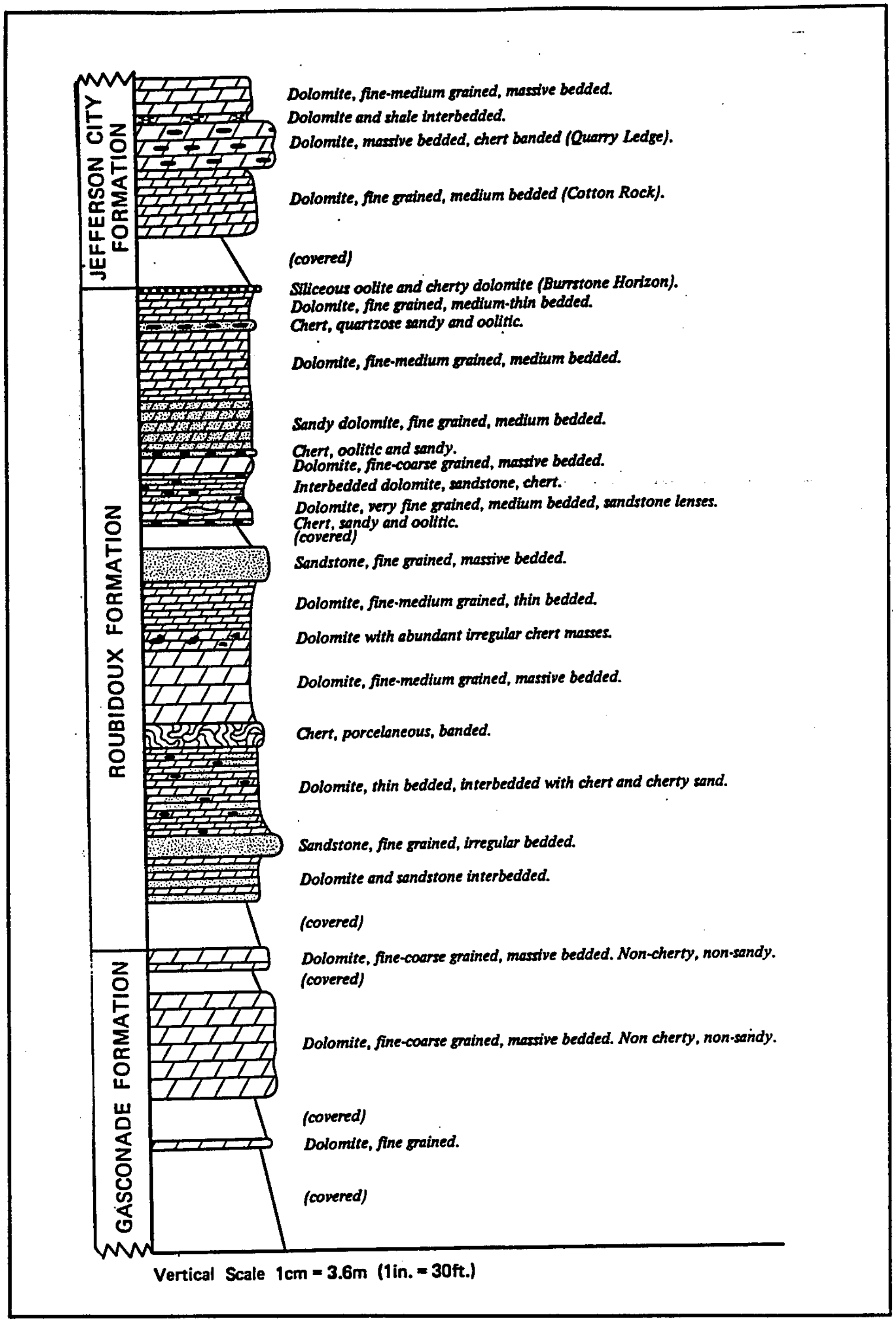


Figure 4. Generalized column section (Green and O'Mallary 1982)

chert (Figure 4). Dolomite predominates but resistant sandstones form conspicuous ledges in the landscape. Dolomite is sandy in parts, light gray to brown, finely to medium-crystalline. It may be chert free or consist of up to fifty percent chert. Sandstones range from 1 in. (3 cm) to 30 ft thick (9 m). Sandstones are predominantly brown to red, fine- to medium-grained quartz sand commonly about 4 ft thick (1 m). The percentage of sandstone in the

formation increases regionally from north to south. Coalesced stromatolite beds occur throughout. The chert varies from common sandy and oolitic types to banded and porcelaneous varieties. The chert in the lower part of the formation appears to be dark gray and finely crystalline. Chert forms in irregular nodules in the dolomite to irregular beds up to 10 ft thick. The entire unit ranges from 130 to 165 ft (40 to 50 m) in thickness.

Thickness of the Roubidoux is hard to determine due to the similarities between it and the Jefferson City Formation above and the Gasconade Dolomite below. The karst process of solution also adds to the differentiation problem. Solutioning is a process whereby strata of a high solubility weathers from beneath strata of lesser solubility. The strata of low solubility descends as material below is removed. Solution process appears to occur to a greater extent on the inside of meanders and to a lesser extent on the outside of meanders. The contact between the Roubidoux and Gasconade Formations generally occurs between elevation 1,000 to 950 ft (305 to 290 m).

Gasconade Dolomite Formation

This unit covers almost 12 percent of the reservation (Figure 3). The Gasconade Formation is found along the valley walls of the Big Piney River and Roubidoux Creek and intermittent tributaries, such as Hurd Hollow, and Smith Branch. It is the bluff former at the base of the valley walls. Outcroppings of the Gasconade Formation occur on the lower backslopes along the northern and central portions of Roubidoux Creek and Big Piney River.

The Gasconade is predominately a light gray to brownish gray, fine-to coarse-grained, medium-to massively bedded dolomite (Figure 4). Unlike the overlying Roubidoux Formation, the Gasconade rarely contains chert and is relatively free of sand in the section outcropping at the fort. Only the upper 165 ft (50 m) of the Gasconade is exposed on the fort. This upper part is highly soluble and contains many caves and springs. For example, Miller Cave and Miller Spring are located in the Gasconade Formation. The upper 30 ft (9 m) of the formation is relatively chert free with a few stromatolitic stringers.

Alluvium

The alluvium occupies 6 percent of the reservation surface (Figure 3). The alluvium is deposited in the floodplains of the Big Piney River, Roubidoux Creek and the major tributaries. Portions of the unit are subject to periodic flooding. Reaches of the Roubidoux Creek are a "losing" stream, i.e., the surface flow is lost to subterranean cavities, and the nature of alluvium and stream morphology is affected in these reaches.

The alluvium consists of a gravelly basal unit, named substratum for the purposes of this report. Overlying the substratum are finer grained sands,

silts, and clays called topstratum. The gravel is predominantly chert derived initially from the weathering of cherty dolomites and later from reworking of the colluvium. The sands are derived from the sandy dolomites and sandstones, and from reworking colluvium and former alluvium. The silt is derived from the loess capped uplands. The lower reaches of the Roubidoux Creek and Big Piney River have a 3 to 6 ft (1 to 2 m) silt veneer topstratum overlying the gravelly substratum. Clay is formed during weathering of dolomites and soil genesis.

Colluvium

Colluvium as mapped in the terrain analysis atlas (Greenhorne and O'Mara 1982) comprises 1 percent of the fort's property. The unit is situated at the base of the valley walls and in the intermittent tributaries of the Roubidoux and Big Piney. The unit occurs on footslopes and toeslopes with local relief 10 to 70 ft (3 to 20 m) above the local streams. The colluvium consists of gravelly sand and clay derived from the adjacent slopes of sandy and cherty dolomite, and sandstone. The silts are largely reworked loess. The gravel portion of the colluvium consists of chert and sandstone fragments.

Residuum

Physical and chemical weathering has altered the bedrock into a residual soil. Dolomite, a soluble carbonate rock, weathers into a reddish silty clay, known as residuum or *terra rosa* for red earth. Chert and sandstone, resistant to weathering, form angular fragments in the matrix of the red clay. Relict bedding structures are visible in soil where no major movement has occurred. The depth to bedrock surface is highly variable. The residual soil thickness varies from less than one foot to more than 100 ft (30 m). Generally, the residual soil is thinnest on the steep hill slopes and thickest on the broad ridges. However, due to the variability of karst dissolution processes, site specific borings are needed for any major construction project. Approximately 18 to 30 in. (45 to 75 cm) of loess covers the stony residuum on the more stable landforms.

Climate

Fort Leonard Wood has a humid temperate climate. The average annual temperature is 60°F. Summer temperatures average 75°F. Winter temperatures average 35°F. Figure 5 shows the mean monthly temperature and precipitation. The average annual precipitation is about 40 in. Over half of this precipitation, 23 in. falls in April through September. Thunderstorms usually happen 45 days a year. The average snow fall is about 13 in. One inch of

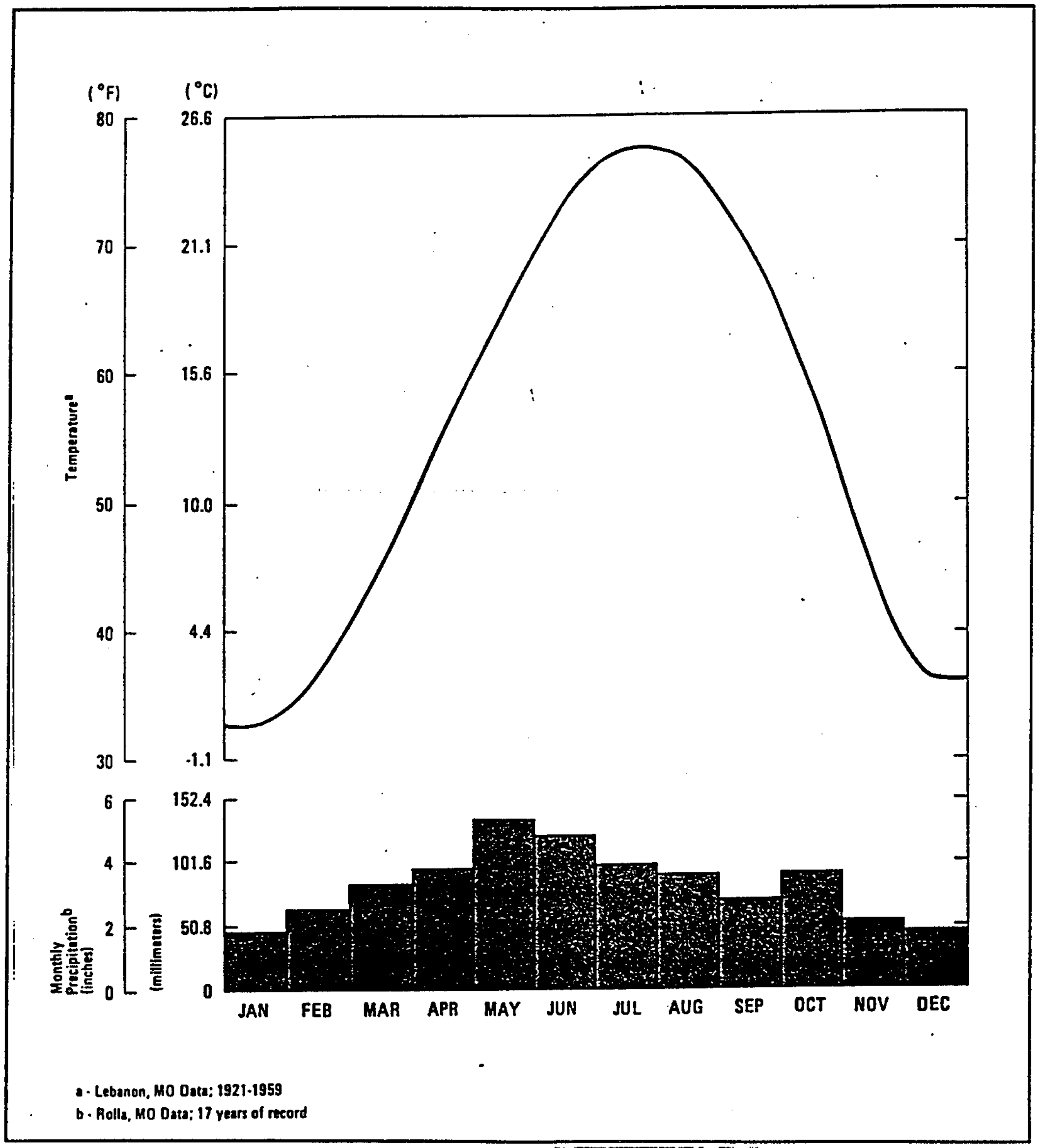


Figure 5. Mean monthly temperature and precipitation (Greenhorne and O'Mara 1982)

snow is on the ground, on average, 13 days a year. More detailed climatic data such as average daily minimum and maximum temperature and average monthly precipitation recorded at nearby Waynesville are available in Wolf (1989).

5 Geomorphic Investigation

Field Studies

Objectives and approach

The objective of the field studies were to conduct soil sampling of selected floodplain reaches to determine temporal, lithological, and morphological relationships between the alluvial surfaces of the Roubidoux Creek and Big Piney River watersheds. Site visits consisted of a general reconnaissance and detailed field investigations. A general reconnaissance was conducted during the first phase to evaluate the results of the previous geologic and soil mapping and to identify locations for later soil borings. The soil geomorphology study of Fort Leonard Wood was begun during the summer of 1993. During detailed field investigations, soil sampling of selected geomorphic surfaces was conducted to obtain sediments for radiocarbon dating and determine general soil properties of the various soil geomorphic units. Soil samples were analyzed and tested in the laboratory to determine specific stratigraphic and chronological properties characteristic of the study area. Samples for radiocarbon dating were taken to reconstruct the general chronology of the study area by dating selected stratigraphic horizons and their associated geomorphic features. Selected sediment samples provided pollen for further analysis of the paleoenvironmental record. In addition, soils data were used to define the sedimentological characteristics of the different geomorphic units to aid in reconstructing the evolution of the study area. Three sites were investigated with a power auger and a series of backhoe trenches. The sites were chosen to represent the different valley landforms and cultural resource management units.

Soil sampling

Soil samples were obtained with a Giddings drilling rig using a 2 in. split spoon and 3 in. auger. Borings to bedrock were conducted at approximately 100 ft (30 m) spacings along transects perpendicular to the stream channel. Sampling with the split spoon was conducted in the upper fine-grained topstratum sediments (sand, silt, and clay). Where refusal occurred, i.e., the split spoon ceased to penetrate the gravel deposits underlying the substratum, the auger drilled to top of bedrock. Descriptions were taken on the finer materials occurring near the surface with decreasing detail recorded with

depth. Additional soil samples and stratigraphic information was obtained by trenching selected spots of the floodplain landscape. A series of backhoe trenches were opened along each of the boring transects to better correlate the lithology of the upper 60 in. (1.5 m) to alloformations. Representative profiles were described in detail (Soil Survey Staff 1993) and sampled for laboratory analysis. A transit survey was conducted on each of the boring and trench location for elevation control. Lithological and pedological investigations were conducted during the summer and fall of 1993 through the use of borings and trenches. Logs of borings and detailed measured sections of the trenches are presented in Appendix A. Boring logs in Appendix A contain descriptions of soil type, color (Munsell), texture, soil structure, consistency, and stratigraphic thickness. Detailed measured sections contain complete soil profile descriptions (Appendix A). Sample cores were photographed in the field and photographic record is on file at USAEWES, for future reference.

Field mapping

Field mapping was initiated in January, 1994 with the charge of mapping alloformations in conjunction with geomorphic surfaces along the Roubidoux Creek and Big Piney River watershed of Fort Leonard Wood. A 1991 aerial photo base at a scale of 1:12,000 was selected for mapping. This scale accommodated the level of detail needed for delineation of small units for the Cultural Resource Management. Units were separated by transversing the stream valleys in a semi-perpendicular line both towards and away from the stream channel. Truck mounted power and hand probe and/or auger were used to investigate the lithology and pedimorphic form (Daniels and Yaalon 1968). Alloformations were separated based on their occurrence on geomorphic surfaces, pedimorphic form, lithology, and drainage. Alloformations were further subdivided in allomembers based on surface color, gravel content, and moisture conditions. Soil-geomorphic mapping results are presented in back of the report as plates. Presentation of the soil-geomorphic mapping uses a township and range section frame. Typical transects across the valleys are presented as soil-geomorphic cross sections. The transects or sections are found as plates.

Laboratory Analyses

Laboratory testing and analyses consisted of preparing detailed boring logs of the soils and sedimentary structure and performing radiometric, and biostratigraphic testing of selected samples. These tests were used to characterize important soil and stratigraphic properties about the different soil geomorphic environments and to aid in the paleoreconstruction of the project. Selected samples from the borings and trenches were transported to University of Missouri, Columbia, MO for later laboratory testing and analysis. Standard soil characterization analysis methods given in Soil Survey Investigation Report No. 1 (Soil Survey Staff 1984) were used. Lab test results are presented in Appendix B.

Radiocarbon dating

Radiocarbon dating of selected stratigraphic horizons was used to determine the general chronology of the Fort Leonard Wood project area. Samples submitted for carbon dating were primarily charcoal from trenches. By dating selected available organic material a time sequence of the valleys could be developed. Twenty soil samples were sent to Beta Analytic Inc., Coral Gables, FL, for radiocarbon dating. Three of the samples submitted had insufficient carbon for analysis. Test results from the submitted samples are presented in Appendix C.

Biostratigraphy

A pollen analysis of selected soil samples from the study area was conducted to determine the effects and significance of changing paleoenvironmental conditions during the Holocene and to assist with the reconstruction of the general chronology for this area. Twenty sediment samples from two trenches and one core were submitted to Dr. James Huber, Archaeometric Laboratory, University of Minnesota, Duluth, for a general pollen analysis. The pollen report by Dr. Huber is presented in Appendix D. The report provides an overview of the laboratory procedures, the pollen analyses, and test results.

6 Soil Geomorphic Units

Introduction

Objectives

The objectives of this chapter are as follows: identify and define the principal soil-geomorphic units or alloformations; classify the alloformations according to their lithology, pedologic development, and relate ages of alloformations to geomorphic position.

Allostratigraphic units

Allostratigraphic units were chosen to represent the divisions of the alluvium and colluvium for archaeological management on Roubidoux Creek and Big Piney River. An allostratigraphic unit is a mappable stratiform body of sedimentary rock that is defined and identified on the basis of its bounding discontinuities (North American Stratigraphic Code 1983). The upper boundary is determined by a geomorphic surface as defined previously. Each alloformation was named for a local cultural feature, i.e., stream crossing, cemetery, town, etc. Alloformations associated with Roubidoux Creek and/or Big Piney River were designated using an ascending numerical system, with TO being the youngest and T7 the oldest. Three additional alloformations were used, two to represent tributary soils. (TRl and TR2) and one to depict alluvial fans (AF). The results of the mapping are presented on plates in the back of the report.

Each alloformation is described by name, stratigraphy, and elevation above the streams in Table 3. The lithology, geomorphology, and important genetic properties are discussed in detail. Table 4 presents the alloformation names used in this study and related soil series occurring in the alloformations. An idealized transect containing all of the allostratigraphic units across the stream valleys is portrayed in Figure 6. Rarely are all the allostratigraphic units preserved in any reach of the Roubidoux Creek or Big Piney River. Figure 6 is presented to give the complete terrace fill sequence for a paradigm or geomorphic framework to envision the valley fill. Actual valley transects are presented in the plate section of the report. The significance of the

Table 3
Formation Symbols and Names, Sediment Type, Soil Horizons[1] and Geomorphic Position

Formation	Sediment and soil characteristics	Elevation Above Streams
T0 Cooksville	Actual stream and gravel and sand bars. All C material.	0-.6m
T1 Happy Hollow	Horizons of stratified gravel and sand. C1-2Ab-2C2-2C3 horizonation.	1.8m
T2 Ramsey	Dominated by sand. Areas of gravel. A-AC-2Ab-2C1-2C2 horizonation.	2.7m
T3 Dundas	Dominated by silt. >15 percent sand. A1-A2-Bw1-Bw2 horizonation.	3.4m
T4 Quesenberry	Equal amounts of particle sizes. Ap-Bw-Bt-C or Ap-Bw1-Bw2-C horizonation.	4.2m
T5 Miller	Dominated by silt. Areas of gravel. Ap-Bt1-Bt2-Bt3 horizonation.	5.5m
T6 Ousley Spring	Dominated by clay. Ap-Bt-Btg1-Btg2 or Ap-E-Btg1-Btg2 horizonation.	6.7m-10.5m
T7 Stone Mill	Equal or dominated by clay. Some pans. Ap-Bt1-2Bt2 or 2Btx-3Bt3 horizonation.	8.5m-18m
T7co Laughlin	Variable. Some pans. Colluvium, residuum. A-Bt1-2Bt2 or 2Btx-3Bt3 horizonation.	12.2m-20m
AF McMann	Dominated by gravel and cobbles. A-Bt12-Bt2 or A-Bw-C horizonation.	3.4m-9m
TR2 Hanna	Mixed alluvium. Dominated by gravel. A-Bw-Bt1-Bt2 horizonation.	7.6m at mouth
TR1 Baldridge	Mixed alluvium. Dominated by gravel. A-C1-C2 horizonation.	2.7m

[1] Lithologic discontinuity horizon designators were used in the alluvium in this report to depict related fluvial packages.

alloformation to the archaeological survey and cultural resource management work on Fort Leonard Wood is discussed in Chapter 8.

Subscripts were employed to represent the differences in allomembers of the formation on the soil-geomorphic maps (see plates in back of report). Subscripts used for lithology, pedogenesis or landform variation from the typical alloformation concept follow:

c: clayey soil
o: dark surface
r: >35% gravel
s: slough
w: wet soil

Table 4
Formation Names, and Related Soil Series[1]

Formation	Related Series
T0 Cooksville	Miscellaneous units. No vegetation.
T1 Happy Hollow	Wideman, Kaintuck, Sandbur, and Relfe. No psamments mapped in Missouri. Entisols (Udifluvents and Psamments).
T2 Ramsey	Lomax, Landes, Lanier, and Cedargap. Mollisols (Hapludolls, Cumulic or Fluventic)
T3 Dundas	Huntington, Boonesboro, Chagrin, and Ray. Mollisols (Hapludolls, Fluventic). Inceptisols (Eutrocrepts, Dystric Fluventic)
T4 Quesenberry	Razort, Billet, and Possumtrot. Alfisols (Hapludalfs, Mollic and Typic) Inceptisols)
T5 Miller	Elk, Ashton, Secesh, Waben, and Moniteau. Alfisols (Hapludalfs, Ultic or Mollic), (Epiaqualfs, Typic).
T6 Ousley Spring	Hartville, Tanglenook, and Okaw. Alfisols (Hapludalfs, Aquic), Epiadualfs, Typic) Mollisols (Argiaquoll, Typic)
T7 Stone Mill	Britwater, Claiborne, Lecoma, Hartville, Yelton, Hobson and Pomme. Alfisols (Paleudalfs, Typic), (Hapludalfs, Aquic) Ultisols (Paleudults, Typic), (Fragiudults, Typic)
T7co Laughlin	Poynor, Clarksville, and Tonti. Ultisols (Paleudults, Typic), (Fragiudults, Typic)
AF McMann	Waben, Secesh. Alfisols, (Hapludalfs, Ultic) Inceptisols (Eutrocrepts, Dystric Fluventic)
TR2 Hanna	Shipsee, Waben, and Secesh. Mollisols, (Argiudolls, Typic)
TR1 Baldridge	Cedargap. Mollisols (Hapludolls, Cumulic)

[1] Source of soil series.

Miscellaneous units were adopted to reflect special circumstances on the fort. Symbols and unit names follow:

- B: Borrow area
- C: Construction area
- CO: Colluvial wedge area
- E: Escarpment W/O bedrock

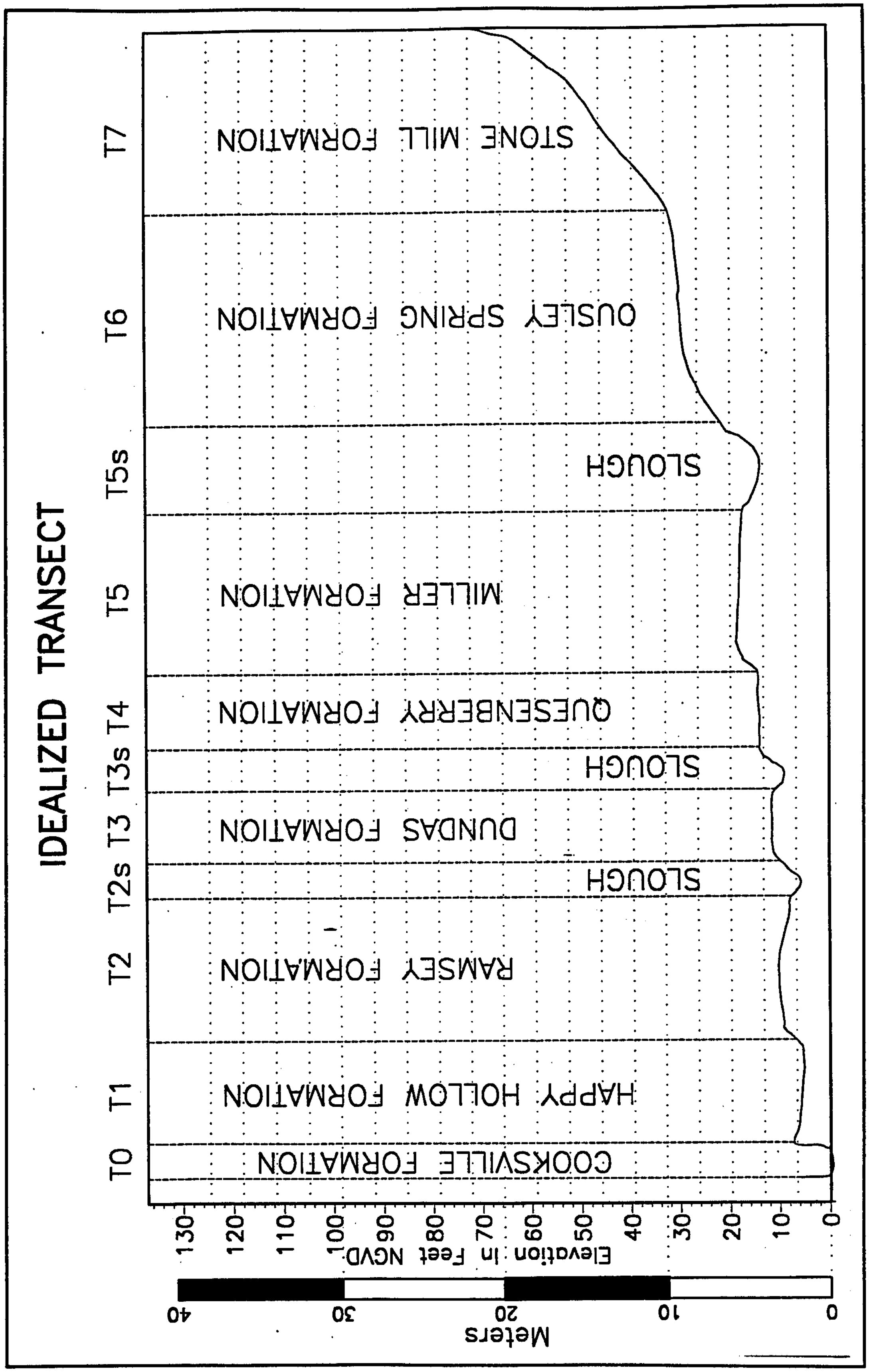


Figure 6. Idealized transect of the allostratiographic units

Spot symbols and some cultural features were displayed on the maps to supply information on small areas within alloformations that could not be delineated and furnish assistance in location. Symbols, features and names follow:

. : wet spot
∴: gravelly area
♂: spring
≈: disturbed area
RES BDY: reservation boundary
→: drainage end
†: cemetery
X: quarry

Alloformations

TO-Cooksville formation

The Cooksville formation consists of channel and associated point bar deposits of the Big Piney River and Roubidoux Creek. The bars are composed of varying amounts of sand, gravel, and cobbles. Amounts of each component are determined by the hydraulics operating in that reach of the stream. These units are narrow and elongated, with an undulating surface composed of convex and concave areas. They usually occur on the inside of meanders. The bars lack well established vegetation with only recent willow (*Salix sp.)* and occasional sycamore (*Platanus occidentals*) present. Elevation above the present steam surface is 0 to 0.6 m. Units range from 1/4 acre to approximately 10 acres in size.

This formation ranges in age from 0 to approximately 100 years before present. Stream processes cause the bars to migrate downstream. The recent nature of its deposition results in no signs of pedogenesis and therefore soils classify into the Entisol order. The pedomorphic form would be a C-Cbl-Cb2 or C1-2C2-2C3. A typical representation of T0 Cooksville can be seen by examining boring LR-1 (Appendix A). This formation is represented as riverwash in the Pulaski County Soil Survey (Wolf 1989).

Tl-Happy Hollow

The Happy Hollow formation consists of sand, gravel, and some cobbles. Vegetation consisting of sycamore (*Platanus occidentals*) and green ash (*Fraxinus pennsylvanica*) has established itself on this formation. It is still in the process of aggradation and/or degradation. Frequent flooding and deposition of all sizes of materials can be expected. Areas viewed exhibited as much as 12 in. (30 cm) of deposition from the flood of 1992. The unit is

narrow and elongated, with an undulating surface composed of convex and concave areas. This unit parallels the present stream. Elevation above the stream surface is around 5.9 ft (1.8 m). Extent of the formation ranges from 1/4 acre to 7 acres.

Materials in this formation range in age from 0 to 300 years before present. Signs of pedogenesis are weak in this formation although most areas have been stable long enough to allow for development of a surface horizon. The majority of the historic surface has been buried by more recent deposition. Soils classify into the Entisol order. The pedomorphic form is a C1-2Ab-2C2-2C3. Representative soil series are Wideman, Kaintuck, Kickapoo, Sandbur, and Relfe. The typical allostratigraphy is presented in Figure 7. Abbreviations used on the typical allostratigraph are listed in Appendix B.

Tl-Allomembers

One member of the Happy Hollow formation was differentiated. This member (Tls) consists of sloughs that had been cut into by the present stream system. They are usually gravelly and some contained standing water.

T2-Ramsey formation

Sand is the dominant component of the Ramsey Formation. Vegetation consists of hackberry (*Celtais occidentlis*), ash (*Fraxinus pennsylvanica*), black walnut (*Juglans nigra*), black cherry (*Prunus sertonia*) and sycamore (*Platanus occidentals*). This formation is the largest unit that still experiences frequent flooding. Associated deposits of sand and fine gravel occur in narrow bands near the edges of the formation and in sloughs. This formation is wide, elongated, and nearly level, running parallel to the present stream. Elevation above the present stream surface is around 8.9 ft (2.7 m). Extent of the formation ranges from 1 to 60 acres.

Deposition of the Ramsey formation spanned the period from 300 to 1,370 years B.P. based on age dates (Appendix C) and possibly reaches up to 1,600 years B.P. (correlated to Brackenridge 1981). Cumulic surfaces have formed on this unit and the dark colors extend to a depth of 40 in. (1 m) or more. Soils classify into the Mollisol order. The pedomorphic form is A-Ab-Cbl-Cb2. Representative series are the Lomax and Landes. A graphic presentation of the typical Ramsey allostratigraphy is found in Figure 8.

T2-Allomembers

Two members are distinguished in the Ramsey formation. The first (T2s) consisted of the sloughs that were very common in this unit. In some areas along the Roubidoux Creek the sloughs formed a braided pattern. Many of these sloughs contain water and some on the upstream side had deposits of

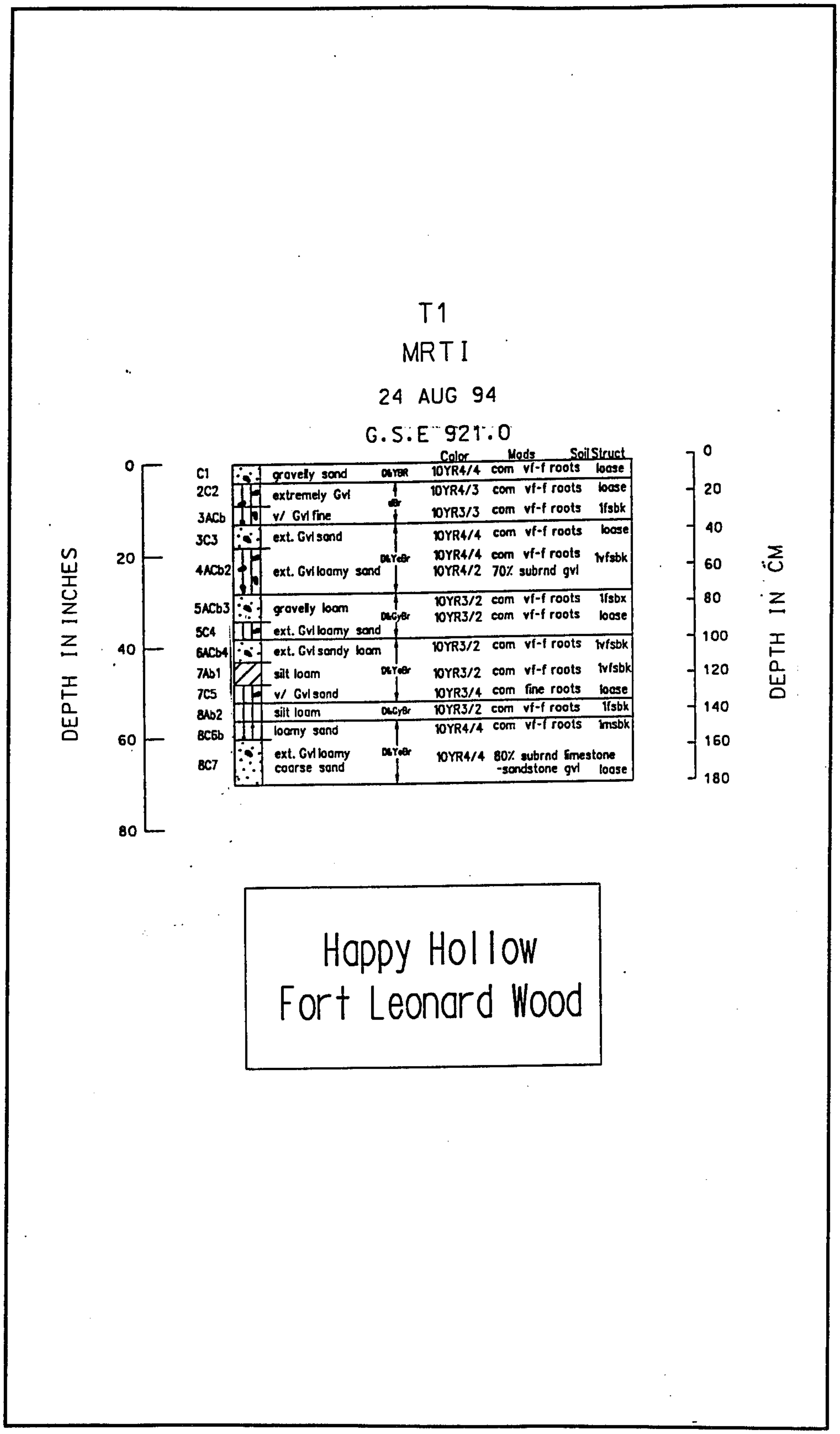


Figure 7. Typical T1 Happy Hollow allostratigraphy

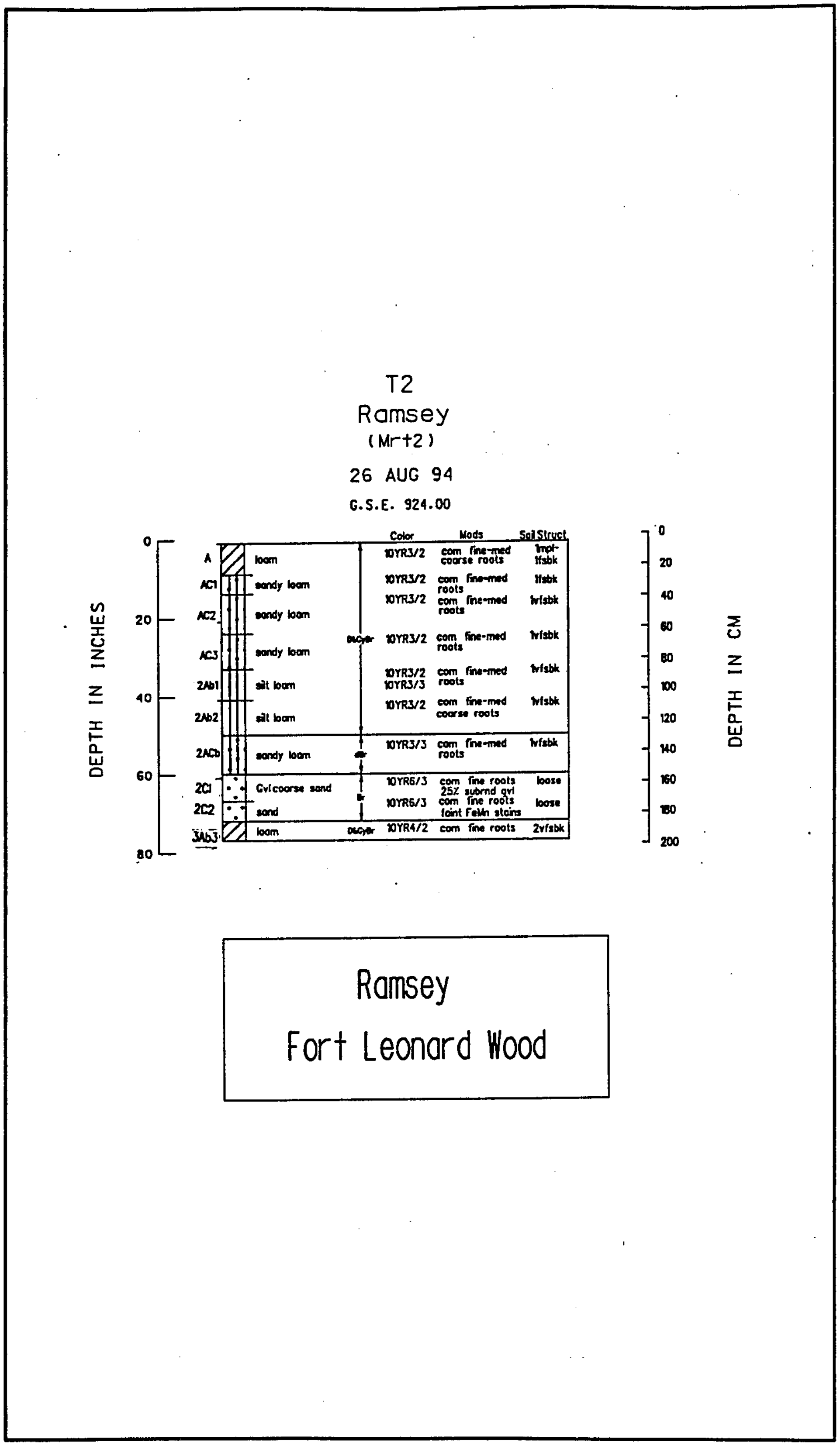


Figure 8. Typical T2 Ramsey allostratigraphy

sand and gravel. The second, (T2r) was composed of similar materials as the Ramsey formation but contained more than 35 percent gravel throughout. This portion of the formation would be represented by the Cedargap or Lanier series.

T3-Dundas formation

Silt and sand are the major components of the Dundas formation with silt dominating. Small areas with up to 35 percent gravel occur. Vegetation consists of hackberry, green ash, black walnut and black cherry. This formation is occasionally to frequently flooded. Deposition of material consists of silt and very fine sand size particles. The unit is wide and elongated to rectangular. It is nearly level and parallels the present stream to an extent. Elevation above the present stream surface is around 11.1 ft (3.4 m). Extent of the formation ranges from 1 to 70 acres.

The age of the Dundas Formation encompasses from 1,600 to 3,000 years B.P. Dark surfaces occur on this formation and extend to a depth of 6 to 18 in. Soils classify into the Inceptisol and Mollisol orders. The pedomorphic form is Al-A2-Bwl-Bw2. Representative series are the Huntington, Boonesboro, Chagrin and Ray. A typical allostratigraphic section is presented in Figure 9.

T3-Allomembers

Sloughs (T3s) were separated as one of the members of the Dundas formation. These sloughs still carry flood water, but few have standing water for long periods of time. One acted as the outlet for an upland drainage system. A few small areas (T3r) were separated from the formation were the gravel exceeded 35 percent.

T4-Quesenberry formation

The Quesenberry formation marks the first major geomorphic separation. The previously discussed formation could be considered as making up the present day floodplains. The Quesenberry formation is the initiation of what could be considered the terrace system. This is based on the flooding frequency and the pedimorphic form.

The Quesenberry Formation is composed of nearly equal amounts of clay silt and sand. Gravel is present in much of the formation and ranges from 5 to 25 percent. Past clearing of this formation is evident and it is now in the process of regeneration. Vegetation consists of successional species of grasses, small trees, and brambles. This formation varies in regard to its flooding frequency, ranging from rarely to nonflooded. Deposition of material consists of very fine sand particles on old natural levees. The unit is nearly level, wide to narrow, and elongated to rectangular. The formation

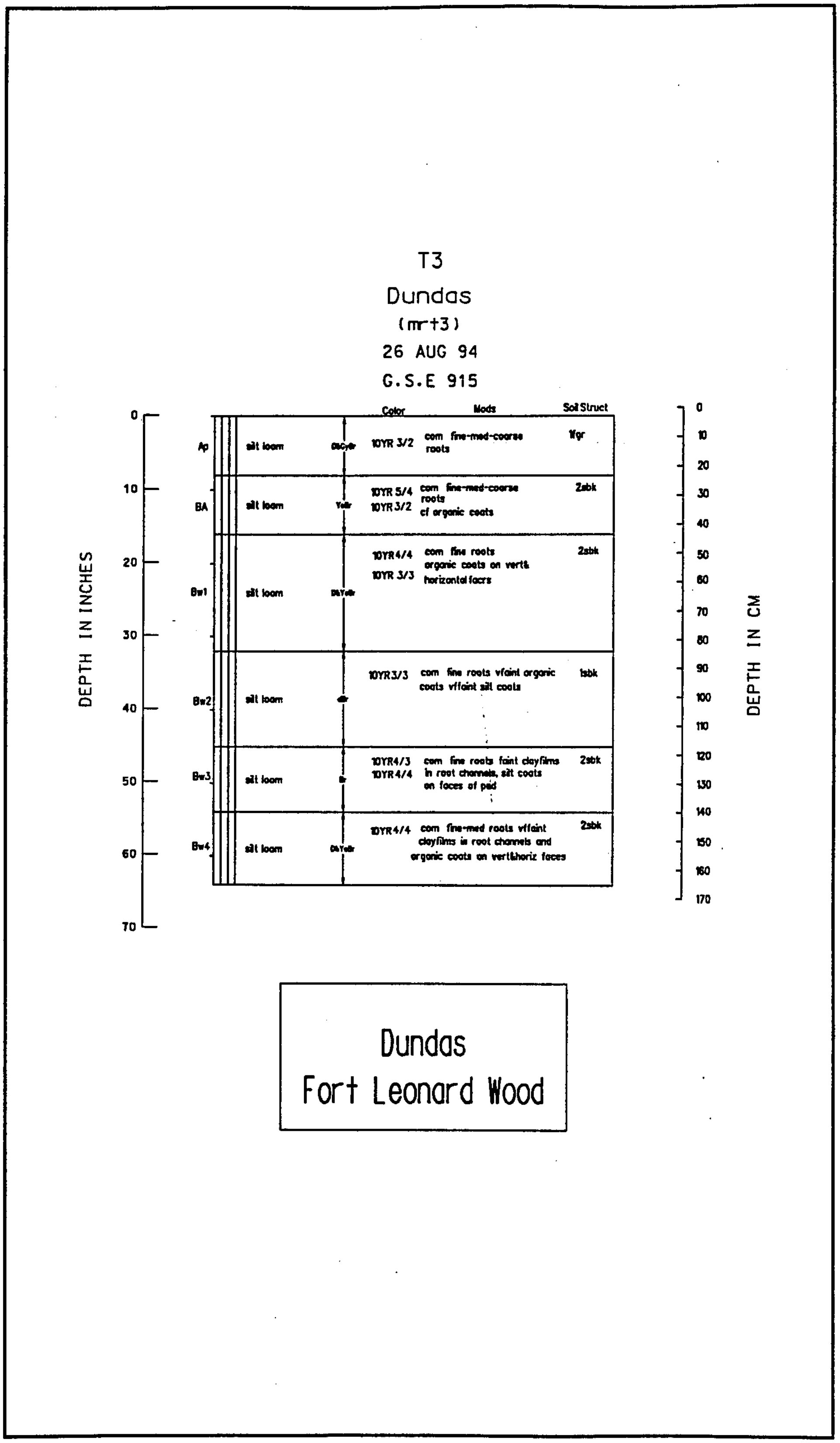


Figure 9. Typical T3 Dundas allostratigraphy

parallels the boundaries of old meanders. Elevation above the present stream surface is around 13.8 ft (4.2 m). Size of the formation ranges from 1 to 20 acres.

The age of the Quesenberry formation extends from 3,000 to 3,900 years B.P. Dark surfaces occur on this formation and extend to a depth of 7 to 8 in. Soils classify into the Alfisol and Inceptisol orders. The pedomorphic form is Ap-BW-Bt-C or Ap-Bwl-BW2-C. Representative series are the Razort, Billet, and Possumtrot. A typical T4 Quesenberry allostratigraphy is shown in Figure 10.

T4-Allomembers

Gravel content exceeded 35 percent in several areas and were designated as (T4r). This is especially prevalent in the tributaries to Roubidoux Creek. This is due to the members being closer to the source of gravel and the decreased volume and velocity of the stream flow. Many sloughs (T4s) or abandoned channels were separated from the formation. The sloughs rarely carry flood water and very few have standing water. Other areas were separated which showed signs of wetness in the subsoil T4w. These areas were usually associated with springs.

T5-Miller formation

The Miller formation is dominated by silt. Gravel is present in some of the formation and ranges from 5 to 25 percent. Past clearing of this formation is evident and it is now in the process of regeneration. Vegetation consists of grasses, small trees, and brambles. Several walnut plantations are located on this formation. This formation is the largest of the formation which is non-flooded or experiences only rare flooding. Flooding on this formation was recorded on only one portion on the southern border of the fort. For all practical purposes this formation can be considered as being non-flooded. The unit is nearly level, wide, and rectangular. The formation parallels the boundaries of old meanders or shows no relation to the present day stream pattern. Elevation above the present stream surface is around 18.0 ft (5.5 m). Extent of the formation ranges from 1/4 to 180 acres.

The age of the Miller Formation is in the vicinity of 4,300 to 10,000 years B.P. Light surfaces dominate this formation Soils classify into the Alfisol order. The pedomorphic form is Ap-Btl-Bt2-Bt3. Representative series are the Elk and Secesh. A representative allostratigraphic section of the T5 Miller Formation is presented in Figure 11.

T5-Allomembers

This formation has the greatest number of allomembers and the description of each follows. Gravel content exceeded 35 percent in several areas and

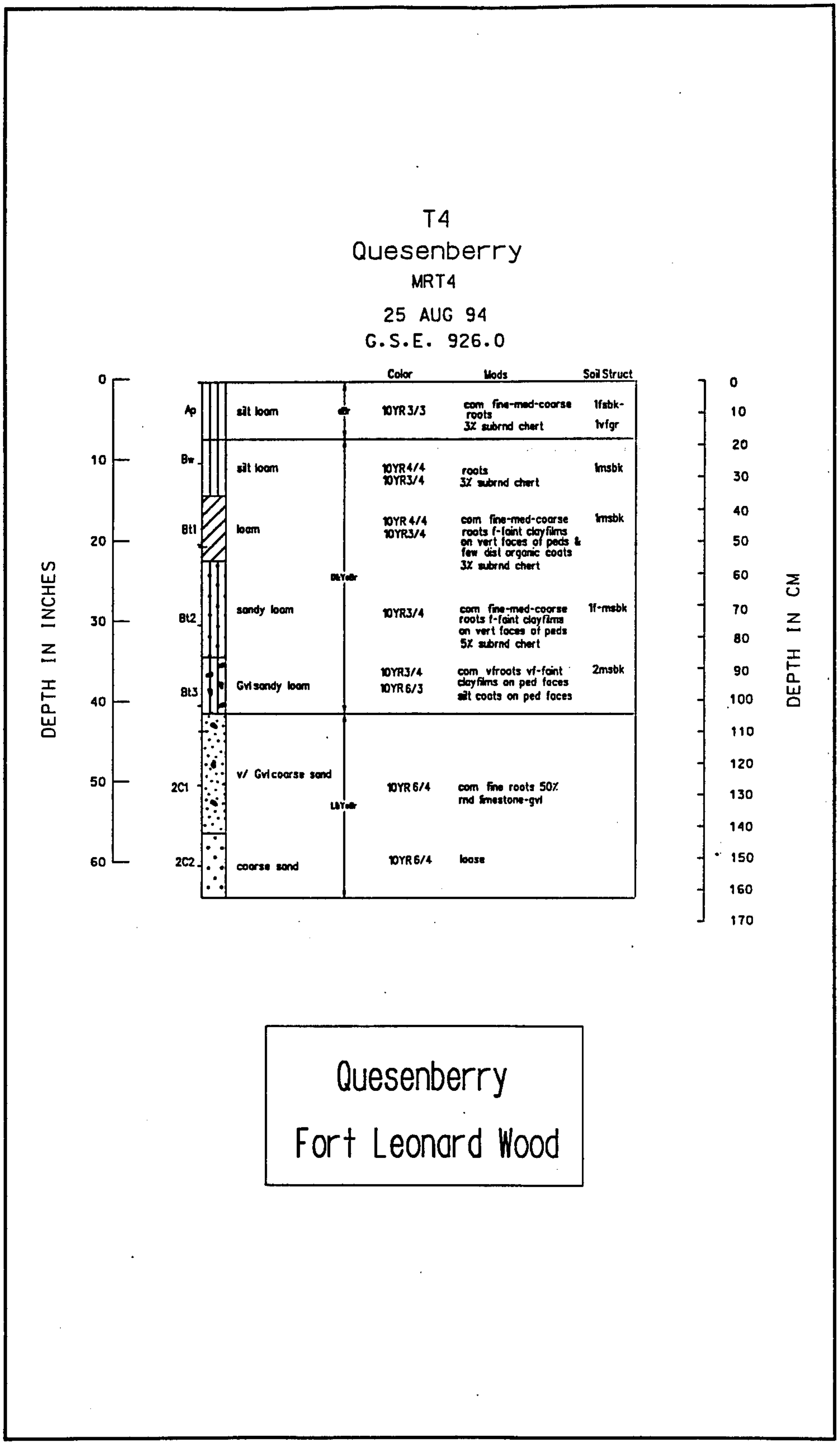


Figure 10. Typical T4 Quesenberry allostratigraphy

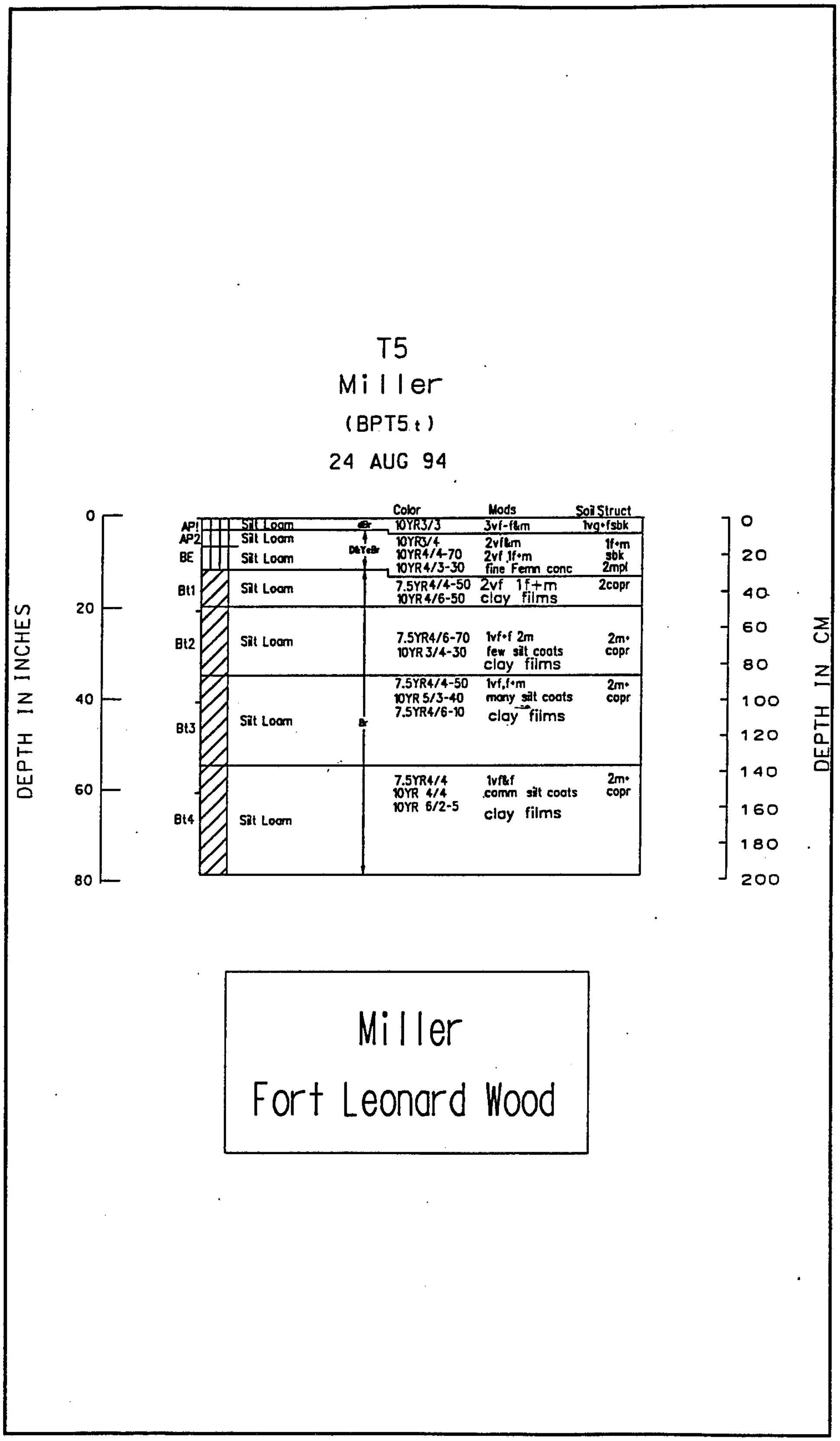


Figure 11. Typical T5 Miller allostratigraphy

were mapped as separate members (T5r). This happened in areas where deposition of gravel from tributaries was incorporated into the formation. Thus, the T5r is interfingered with time equivalent tributary (TR2) deposits. This portion of the formation would be represented by the Waben series. A few sloughs (T5s) were separated from the formation. These no longer carry flood water but paleodrainage can be inferred from their location. Some contain ponded water from seepage and direct input from upland drainages.

Several members were separated which showed signs of wetness in the subsoil and surface (T5w). Figure 12 portrays a typical T5w Miller wet allostratigraphic section. Some of them had standing water. The Moniteau series represents this member. Dark surfaces occur in several areas also. These zones (T5o) possibly represent open grassland or savannahs. These are represented by the Ashton series. Figure 13 portrays a typical T5o Miller organic allostratigraphic section. The final members of the Miller formation consist of dark surfaced, wet areas (T5wo) and dark surfaced, wet and clayey areas (T5wco). These members are in some cases associated with springs. The Hepler series represents the (T5wo) member and the Dunning series represents the (T5wco) member.

T6-Ousley Spring formation

Clay is the dominate particle size of the Ousley Spring formation. As a result the formation is characterized by a somewhat poorly drained class; poorly drained portions are separated as an allomember. Past clearing of this formation is evident and it is now in the process of regeneration. Vegetation consists of grasses, sedges, small trees, and brambles. This formation is non-flooded. The formation is gently sloping, wide, and rectangular. The formation shows no relation to the present day stream pattern and the majority of this formation is found in old cut-off meanders. Elevation above the present stream surface ranges from 22.0 to 34.4 ft (6.7 to 10.5 m). Extent of the formation ranges from 2 to 120 acres.

The Ousley Spring formation age is estimated to range from 10,000 to 55,000 years B.P. based on correlations with Brackenridge's (1981) geochronology. Light surfaces dominate this formation. Soils classify into the Alfisol and Mollisol orders. The pedomorphic form is Ap-Bt-Btgl-Btg2. The representative series is Hartville. A typical representation of T6 Ousley Springs is shown in Figure 14.

T6-Allomembers

One member which showed signs of wetness throughout the soil profile (T6w) was distinguished. This unit characteristically had standing water during the spring season. The Okaw series would represent this member. Dark surfaces occurred other members (T6o and T6wo) and were associated with the abandoned channels or old cut-off meanders. Drainage covered both

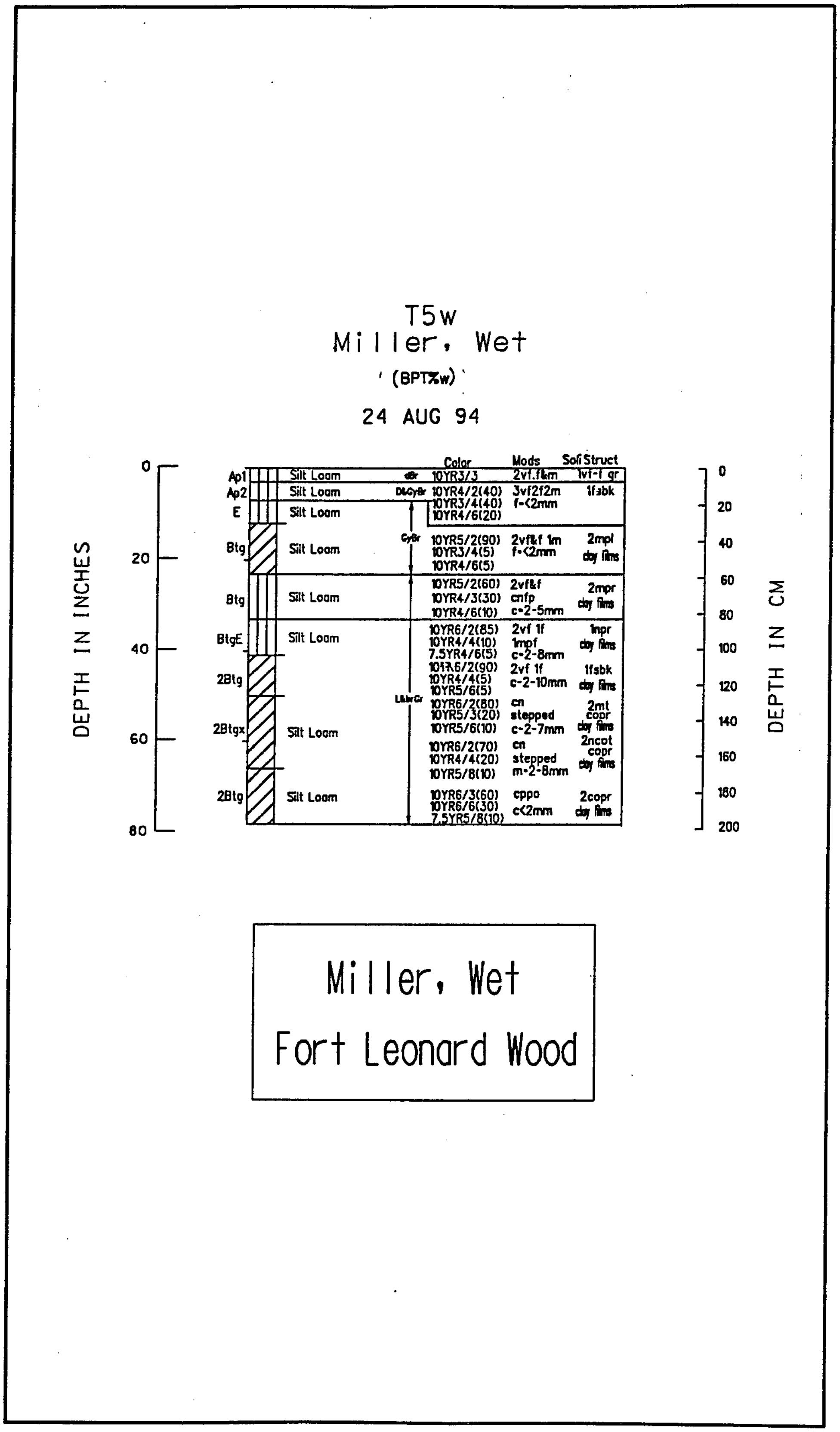


Figure 12. Typical T5w Miller, wet allostratigraphy

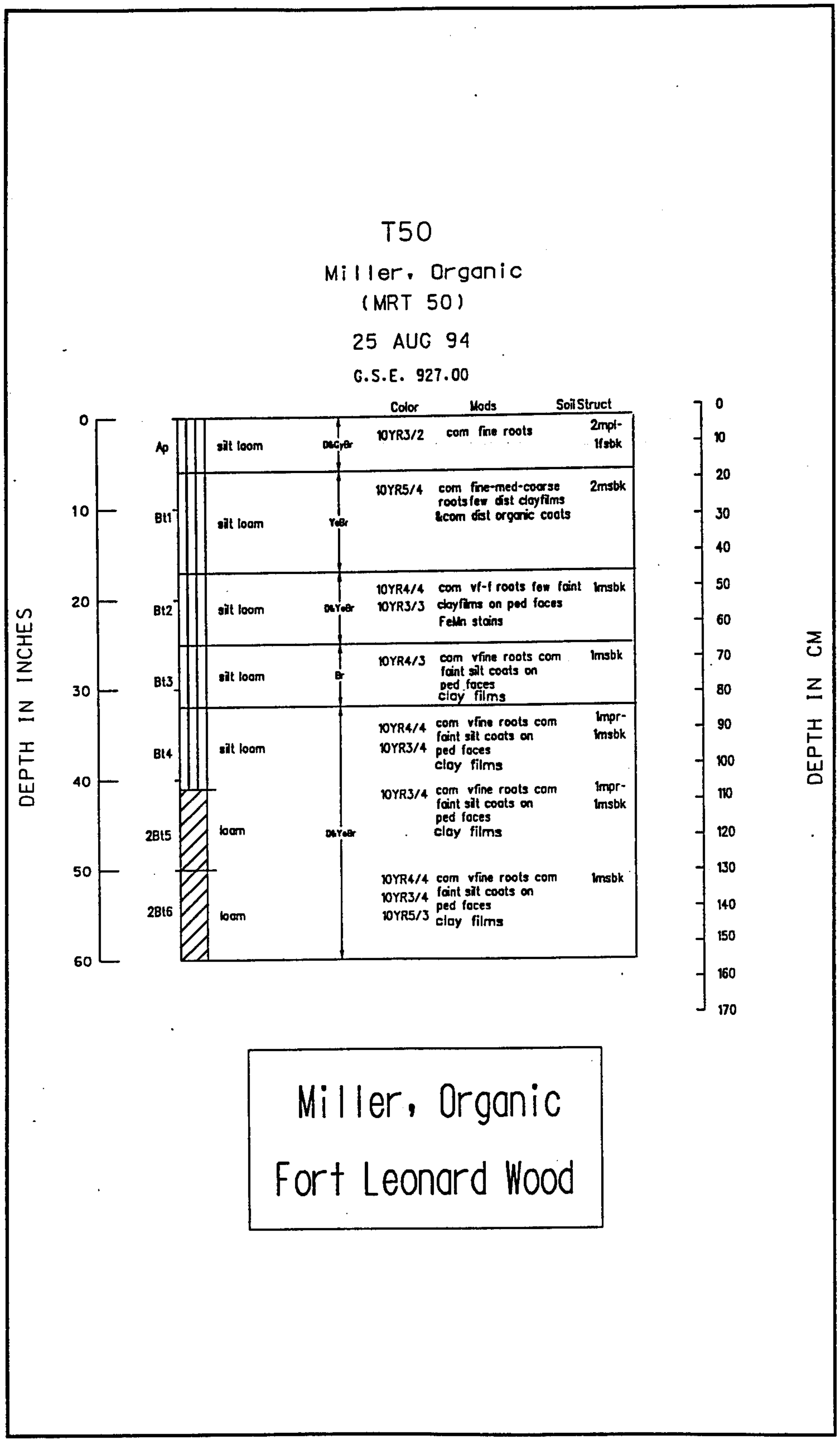


Figure 13. Typical T5o Miller, organic allostratigraphy

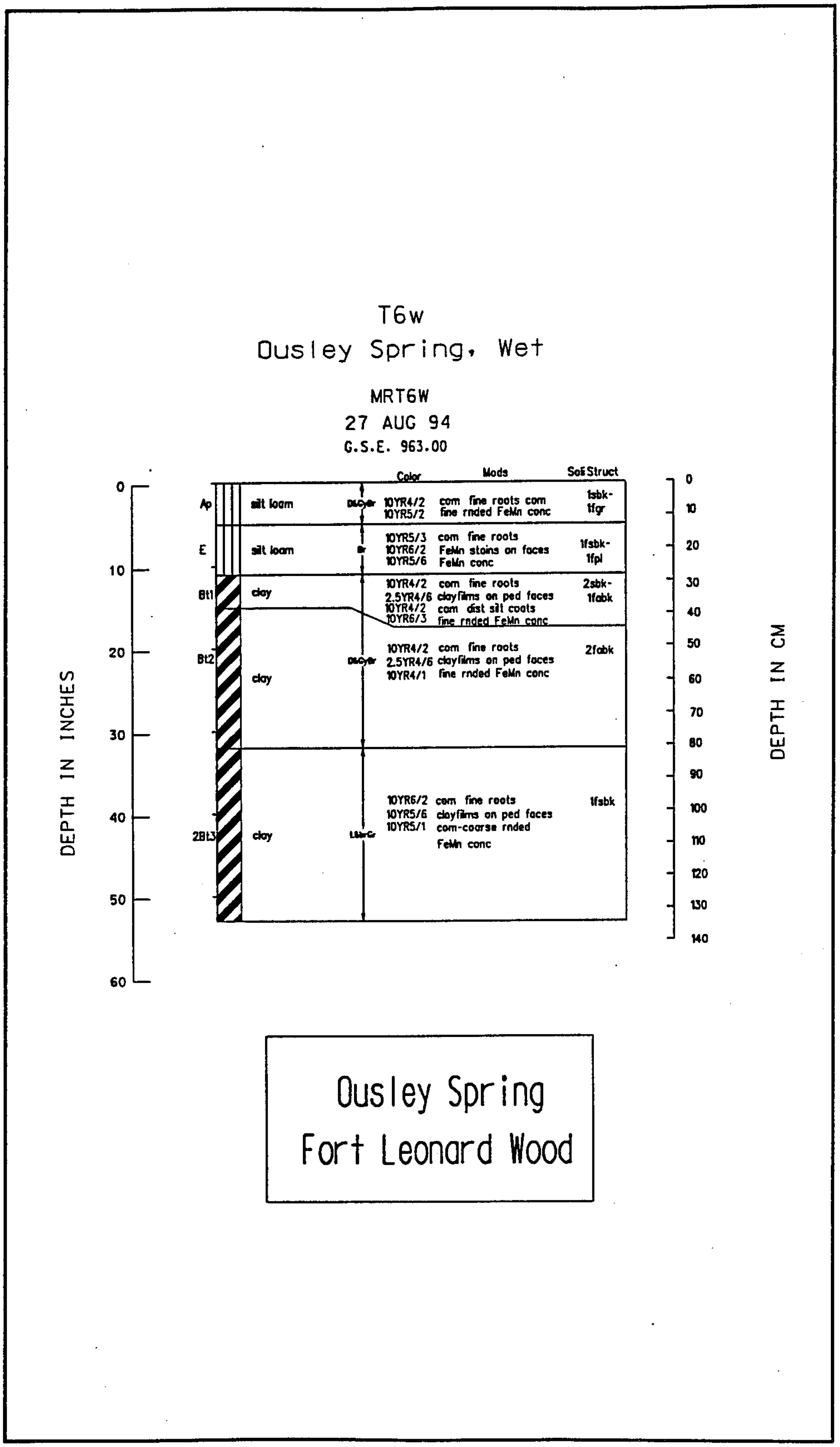


Figure 14. Typical T6 Ousley Spring allostratigraphy

classes describe above. These sites possibly represent open grassland or savannahs. The T6wo member is represented by the Tanglenook series.

T7-Stone Mill formation

The Stone Mill formation represents the second major geomorphic separation. It occurs as remnants of a much older surface and would be considered a strath terrace. Height above the younger formation ranges 10 to 20 ft (3 to 6 m). An erosional escarpment with or without bedrock occurs in some locales.

The Stone Mill Formation is composed of nearly equal amounts of sand, silt, and clay. Gravel ranges from 15 to 35 percent. The upper material consists of loess, reworked loess, colluvium, hillslope sediments, or any combination of the four. The lower material constitutes a paleosol of alluvial or colluvial gravels in a red sandy clay matrix. A fragic horizon is present in some formation at the contact between the two materials. Past clearing of this formation is evident and these areas are now in the process of regeneration. Vegetation consists of grasses, small trees, and brambles. Forested areas have an oak-hickory cover. This formation is non-flooded. The formation is moderately to strongly sloping, wide, and rectangular. The formation shows no relation to the present day stream pattern. Elevation above the present stream surface ranges from 27.9-59.0 ft (8.5 to 18 m). Extent of the formation ranges from 2 to 40 acres.

The age of the Stone Mill Formation ranges from 10,000 for the loess deposition to >130,000 years B.P. according to Brackenridge (1981). The surface of the formation is light in color. Soils classify into the Alfisol and Ultisol orders. The pedomorphic form is Ap-Btl-2Bt2-3Bt3 or Ap-Btl-2Btx-3Bt3. The formation is represented by the Britwater, Claiborne, Lecoma, and Yelton series. Typical T7 Stone Mill allostratigraphy is presented in Figure 15.

T7-Allomembers

Several members were distinguished which showed signs of wetness and increased clay accumulation in the upper portion of the subsoil (T7wc). The Hartville series represents this member, even though it is not a soil mapped on strath erosional terraces. One area was separated out as a wet, clayey unit with a dark surface (T7wco). Given the smallness of this unit and the rarity of its occurrence it will have a low importance. Gravel exceeded 35 percent in some parts of the formation (T7r). These were usually small remnants which occurred along tributaries.

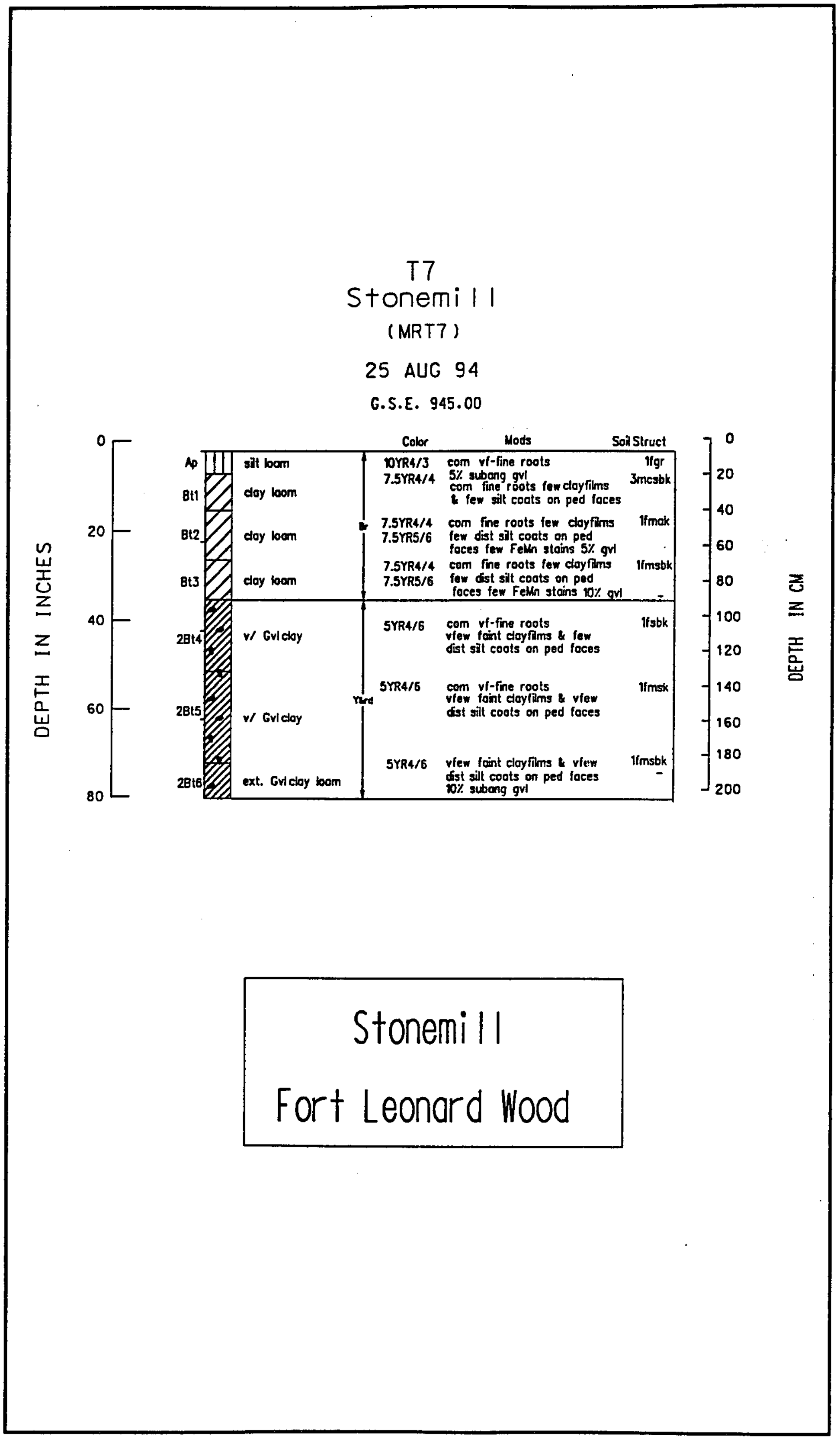


Figure 15. Typical T7 Stone Mill allostratigraphy

T7co-Laughlin unit

The Laughlin unit represents the upland footslopes. It was distinguish in this study from alluvial soils because of its close proximity to the stream channel, its geomorphology, and the presence of overlapping archaeological sites. It is not considered an alloformation on account of its residual identity.

The Laughlin unit is composed of variable depths of very gravelly colluvium over residuum. In some areas a loess cap is present. A fragic horizon occurs in some areas at the contact of the contrasting materials. Typical T7co Laughlin stratigraphy is portrayed in Figure 16.

Infrequent clearing of this unit has left a forest cover that consists of oaks, hickories, and pines. This unit is non-flooded. It is moderately to strongly sloping, narrow, and rectangular. The unit shows no relation to the present day stream pattern. Elevation above the present stream surface ranges from 40.0 to 65.6 ft (12.2 to 20 m). Extent of the formation ranges from 1 to 20 acres.

The age of the Laughlin unit is similar to that of the Stone Mill Formation. It ranges from 10,000 to >130,000 years B.P. The surface of the unit is light in color. Soils classify into the Ultisol order. The pedomorphic form is A-Btl-2Bt2-3Bt3 or A-Btl-2Btx-3Bt2. The unit is represented by the Clarksville, Poynor and Tonti series.

AF-McCann formation

The McCann formation consists of alluvial fans. Alluvial fan remnants and recent fan deposits are delineated. Some portions include both. The formation is found as deposits on the majority of the alloformations.

The formation is dominated by gravel and cobbles. A fining downward from the mouth of the tributary occurs. A few areas were cleared in the past and are in the process of regeneration; other areas were not cleared and remain oak-hickory forest. This formation is nonflooded in the sense of being inundated by Roubidoux Creek, but tributaries flow over the surface with deposition sediment as lateral channel migration takes place. The formation is moderately sloping, fan-shaped, and shows no relation to the present day stream pattern. The formation is related to the materials and size of the tributary from which it arises. Elevation above the present stream surface ranges from 11.1 to 29.5 ft (3.4 to 9 m). Extent of the formation ranges from 1/8 to 10 acres.

The McCann formation ranges in ages from 0 to 55,000 years B.P. The surface of the formation is light in color. Soils classify into the Alfisol or Inceptisol orders. The pedomorphic form is A-Bw-Btl-2Bt2 or A-BW-C. This formation is represented by the Waben series.

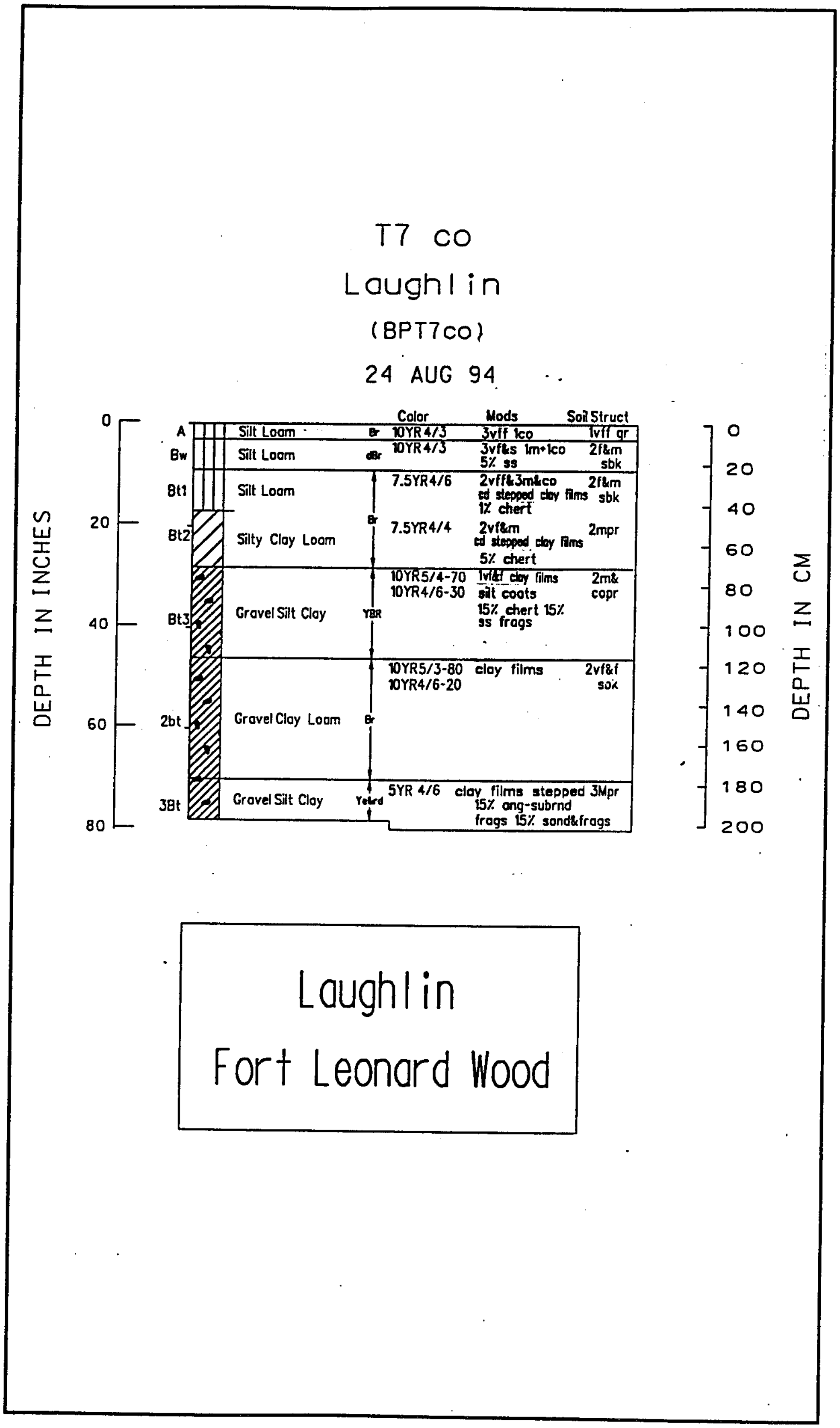


Figure 16. Typical T7co Laughlin stratigraphy

TR1-Baldridge formation

The Baldridge formation is found in the large to small tributaries of Roubidoux Creek. On the basis of age and pedimorphic form this formation is probably related to the Ramsey Formation. It was separated based on differences in gravel content and position in the watershed.

Mixed alluvium dominated by gravel is the main constituent of the Baldridge formation. Areas within the larger tributaries were cleared in the past and are in the process of regeneration. Smaller tributaries were not cleared and remain in a oak-hickory forest. This formation is nonflooded in the sense of being inundated by Roubidoux Creek, but flooding does occur to some extent as a result of over bank flow from tributaries. The amount of this flooding is dependent on the size of the tributary and the vegetative cover. The formation is moderately sloping, linear, and parallels present day tributary channels. The formation is related to the materials and size of the tributary from which it arises. Elevation above the present stream surface is 8.9 ft (2.7 m). Extent of the formation ranges from 5 to several hundred acres.

The Baldridge formation ranges in age from 0 to 1,600 years B.P. The surface of the formation is cumulic with the dark materials extending to a depth of 40 in. (1 m) or more. Soils classify into the Mollisol order. The pedomorphic form is A-Cl-C2. This formation is represented by the Cedargap series. Figure 17 presents the typical (TR1) Baldridge stratigraphy.

TR2-Hanna formation

The Hanna formation is found in the small to mid-size tributaries in the northern section of Roubidoux Creek. This formation is deposited on or truncates the formation older than the T4 Quesenberry. Mixed alluvium dominated by gravel is the main constituent in the upper Hanna formation. The lower portion consists of clay with high content of gravels and cobbles. The majority of the tributaries were not cleared and remain as an oak-hickory forest. A few mid-sized tributaries were cleared and are in the process of regeneration. This formation is rarely if ever flooded because the present channel is truncated below the level which would allow flooding on the formation surface. The formation is moderately sloping, linear, and parallels the present day channel of the tributaries. The formation is related to the materials and size of the tributary from which it arises. Elevation above the present stream surface is 24.9 ft (7.6 m). Extent of the formation ranges from 2 to 200 hundred acres.

The Hanna formation ranges in age from 4,000 to 8,000 years B.P. The surface of the formation is dark and the surface extends to a depth less than 24 in. Soils classify into the Mollisol order. The pedomorphic form is A-Bw-Btl-Bt2. This formation is not represented by an established series. Figure 18 presents a typical (TR2) Hanna stratigraphy.

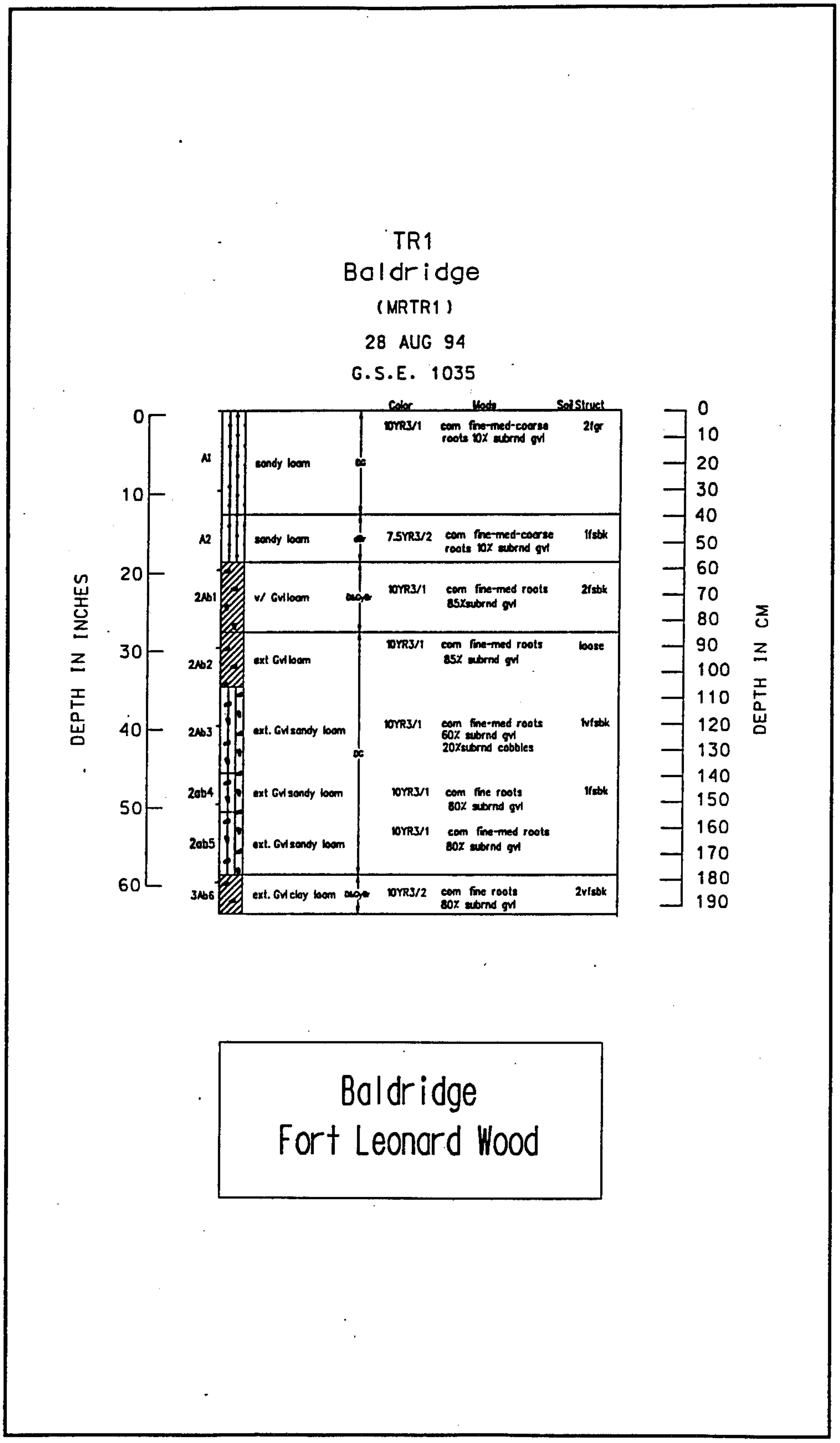


Figure 17. Typical TR1 Baldridge stratigraphy

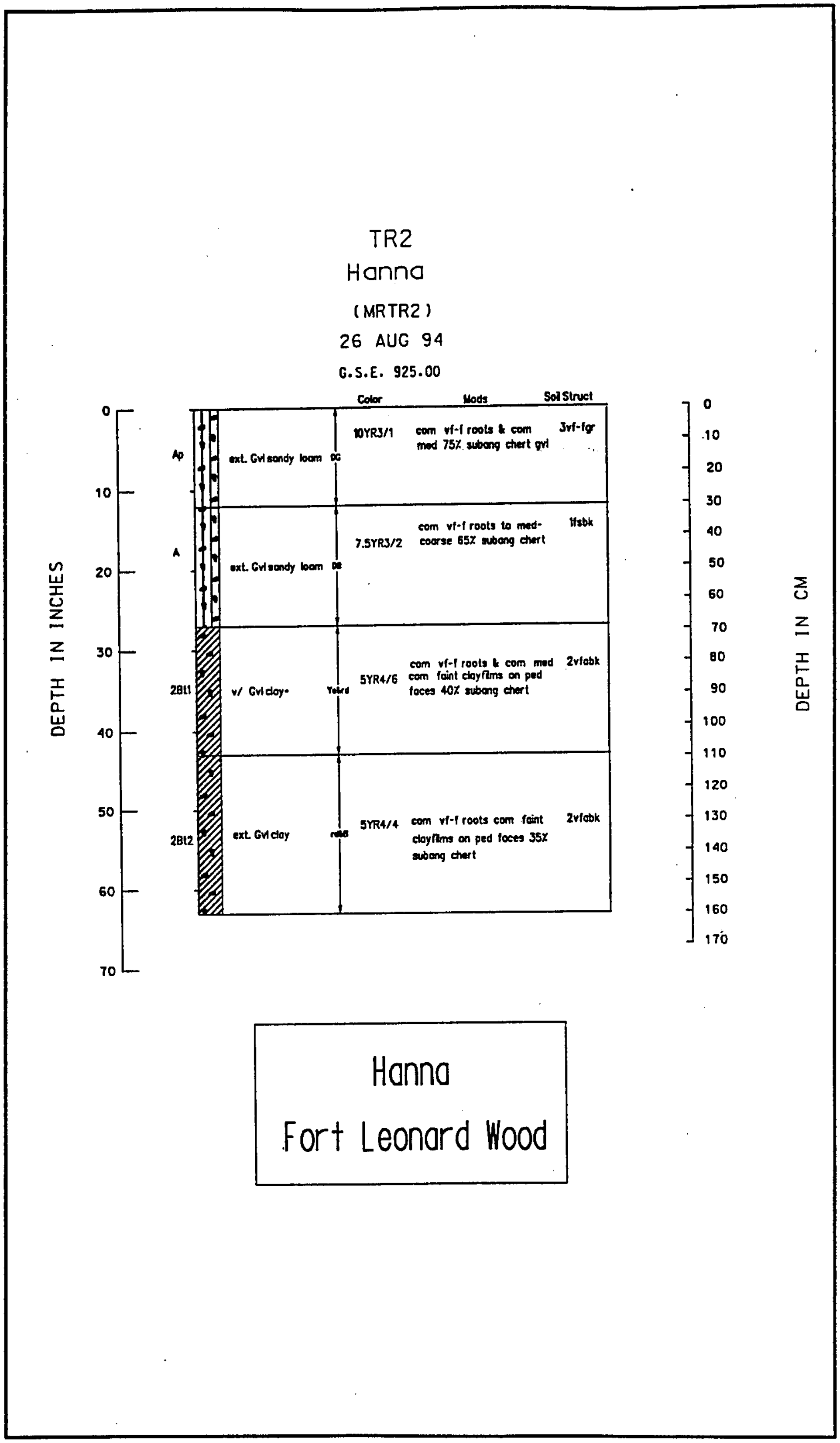


Figure 18. Typical TR2 Hanna stratigraphy

Miscellaneous Units

B-Borrow areas

This unit constitute sites that have had the original surface and subsoil removed for construction purposes. These sites are generally located in the older formation and have no vegetative cover.

C-Construction areas

This unit includes tracts of land utilized for construction of military structures, parking areas, and training areas. It also includes areas where training for construction has taken place.

CO-Colluvial wedge area

These units consist of zones of colluvial accumulation at the base of slopes. They are dominated by gravel.

E-Escarpment W/WO bedrock

A steep relatively short erosional escarpment is the main component of this unit. Some areas have bedrock exhibited along the lower edge. They are a result of the truncating action of the river system after the abandonment of the Stone Mill formation, or associated allostratigraphic unit.

7 Site Investigations

Objective and Approach

A representative site on each stream reach of the cultural resource zones was selected. Testing of these representative sites on the Big Piney River and Roubidoux Creek was conducted to collect detailed data on the relationship, sequence of the lithology, and the level of pedogenesis of each geomorphic surface. It became visibly apparent from borings and trenches that each geomorphic surface was associated with a lithologic package that was peculiar to that surface. Each of these "packages" exhibited a particular level of pedogenesis associated with clay, sand, and organic carbon distribution and pedologic development.

Overlying bedrock is a gravelly unit termed "substratum." The substratum is composed of gravel in varied matrix of clay to sand. Overlying the substratum are fine grained units termed "topstratum." Detailed descriptions of the topstratum were recorded both in the boring logs and the trenches (Appendix A). Lithological information presented in this report uses the Unified Soil Classification System (USCS) terms and symbols. Figure 19 is a guide for comparing the USCS and the USDA soil texture types.

Based on topographic expression, lithology, pedology, and Carbon^{14} dates, the transect profiles were differentiated into soil-geomorphic units. Contacts between units were drawn based on changes in topographic expression, geomorphic position, lithology, pedology, age, or a combination there of. Thus, each topstratum "package" has a landscape expression, distinct lithology, pedogenic signature, and where data are available, age range. Simply, the topstratum package and its underlying substratum are soil-geomorphic units. According to the Stratigraphic Code (1983) these colloquial packages or informal soil-geomorphic units would fit into the concept of allostratigraphic units. For the purpose of this report the terms will be used interchangeably.

The trenches also revealed that the soil-geomorphic units commonly over lap. This is indicative of separate periods of downcutting and deposition. Examination of boring and trench transects shows the cut and fill sequences.

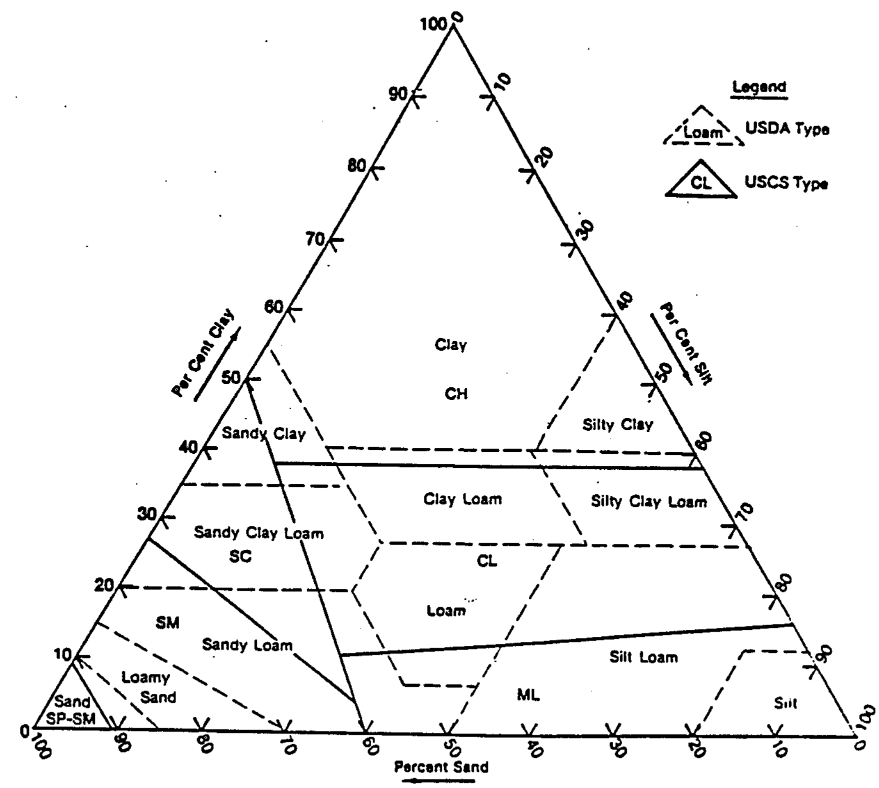


Figure 19. Guide to compare USCS and USDA soil types

The information collected through the use of the trenches was synthesized into a landscape model for mapping purposes. The soil-landscape paradigm (Daniels and Hammer 1992) forms the theoretical basis for the extrapolation in this study. The working hypothesis was that the relationship of stratigraphy, soil development, and geomorphic surfaces observed in the borings and trench can be extrapolated across the entire fluvial landscape of the fort. Therefore, the following transect and trench descriptions not only characterize the representative site but also form the basis of the mapping strategy for both streams on the fort. The site investigations for the Big Piney, and the Lower and Upper Roubidoux are discussed individually.

Typical Transects

Big Piney River at Happy Hollow

The study area on the Big Piney at Happy Hollow is located as shown on Figure 20. Figure 21 presents the valley cross-section of the Big Piney River in the vicinity of Happy Hollow. The 20 times vertical exaggeration emphasizes the steep bluffs formed by the Roubidoux and Gasconade formation. Alluvium and colluvium fill the bottom of this deep valley. The colluvial and alluvial fill is idealized. Based on topographic expression and previous works, the alluvial is subdivided into a historic and Holocene component.

In order to test the idealized valley fill, (Figure 21) a transect perpendicular to the Big Piney River, at Happy Hollow was selected. Nineteen borings and three trenches were used to dissect this representative transect of the Big Piney. The location of borings and trenches is presented in Figure 22. The borings' lithology are shown on Figure 23, along with the C^{14} dates. The basic data for interpreting the geomorphic development is provided. An interpretation is portrayed on Figure 24. Individual boring logs with detailed descriptions are presented in Appendix A. Detailed stratigraphy of trenches HH T-1, HH T-2, and HH T-3, shown as insets on Figure 23, are presented as Figures 25, 26, and 27, respectively.

Examination of Figure 24 reveals that the Gasconade formation bedrock surface is uneven and stepdowns at station 1550 as it approaches the river on left. Residuum occurs at 800 ft from the river in boring HH-17. Everywhere else overlying bedrock is substratum composed of gravel in varied matrix of clay to sand. Overlying the substratum are fine-grained topstratum units. Based on topographic expression, lithology, and C_{14} dates, the transect was differentiated as shown on Figure 24. Contacts between units were drawn based on changes in topographic expression, geomorphic position, lithology, pedology, age, or a combination there of.

The transect (right side of Figure 24) starts with boring HH-1. Borings HH-1, 2, and 3 penetrated a silt and well developed clay soil overlying a thin substratum and shallow bedrock. Trench HHT-1 (Figure 25) reveals from 0.5 to 2.0 ft (.15 to 0.6 m) of fill. This area had been used for track vehicle

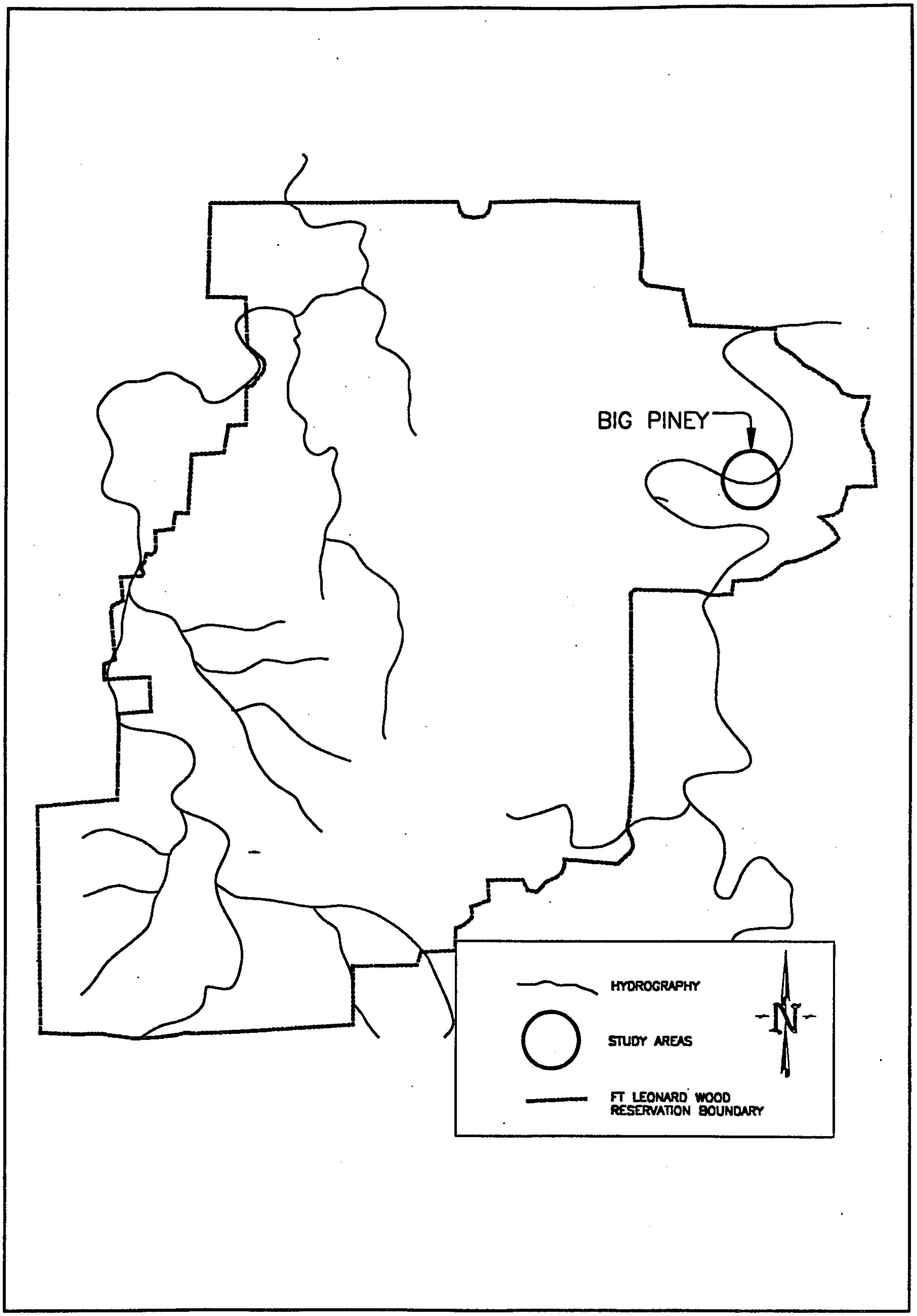


Figure 20. Location map for the Big Piney river at Happy Hollow site

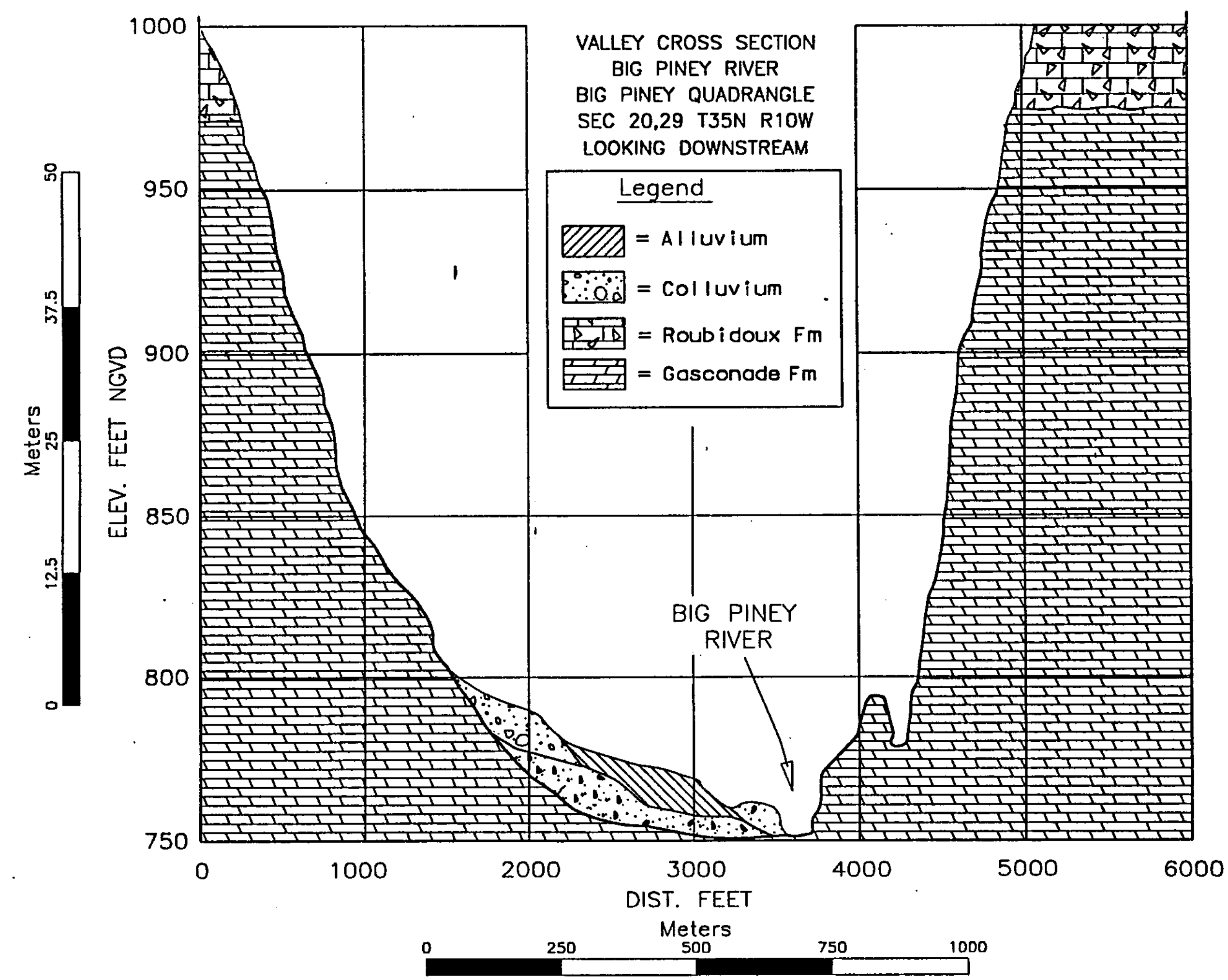


Figure 21. Valley cross-section for the Big Piney at Happy Hollow site

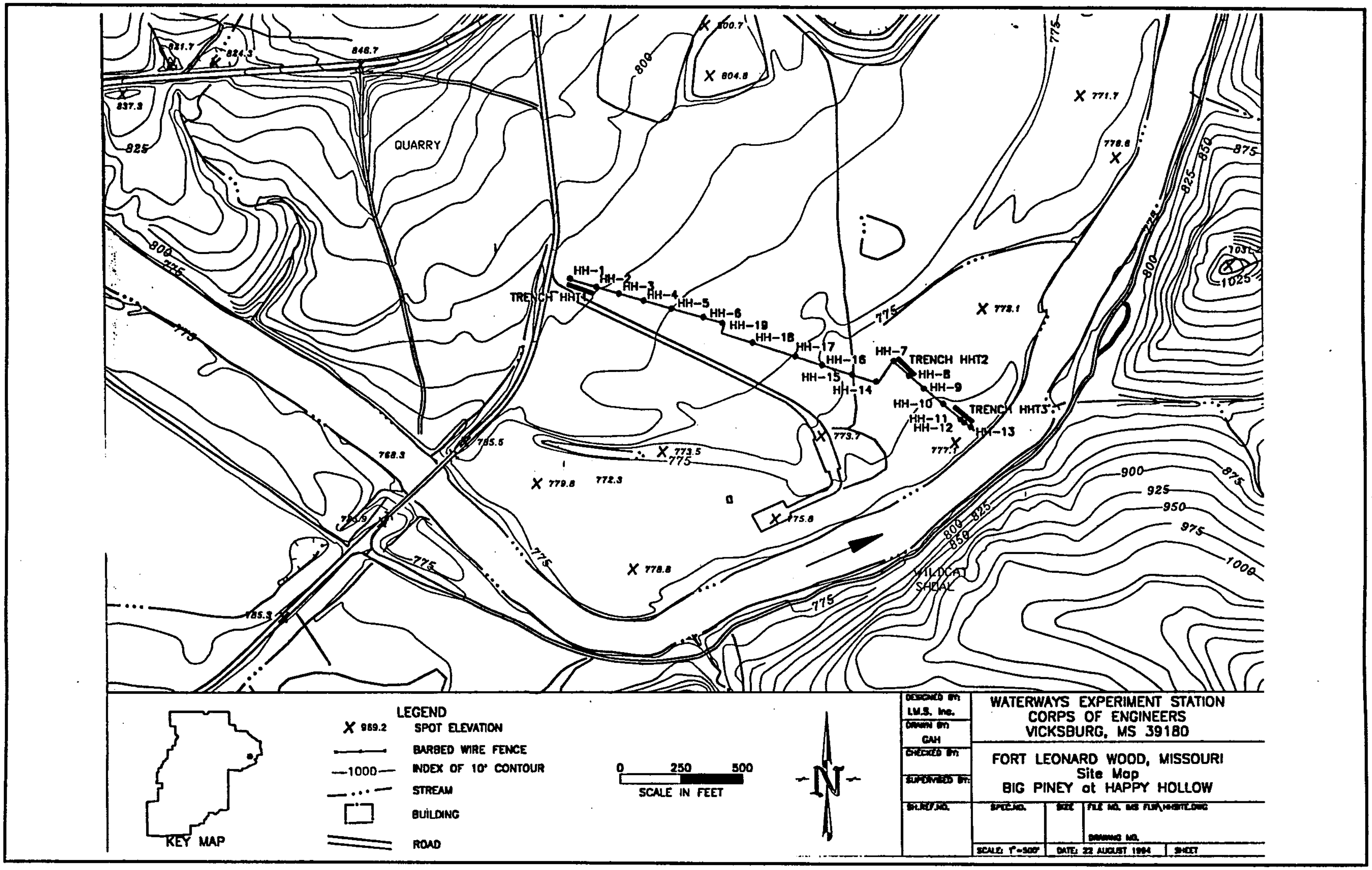


Figure 22. Location map of borings and trenches for the Big Piney at Happy Hollow site

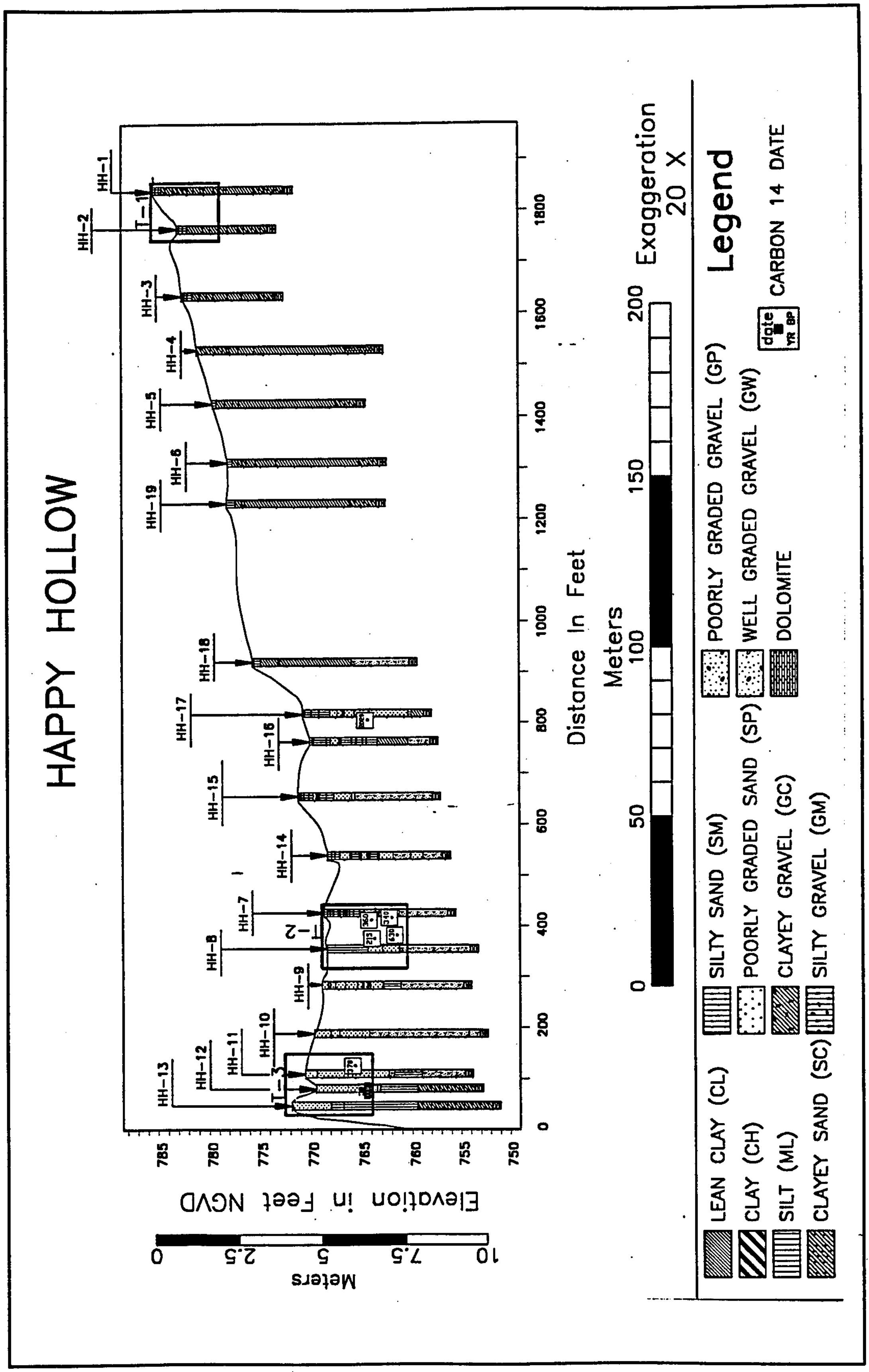


Figure 23. Borings and trenches transect data for the Big Piney at Happy Hollow site

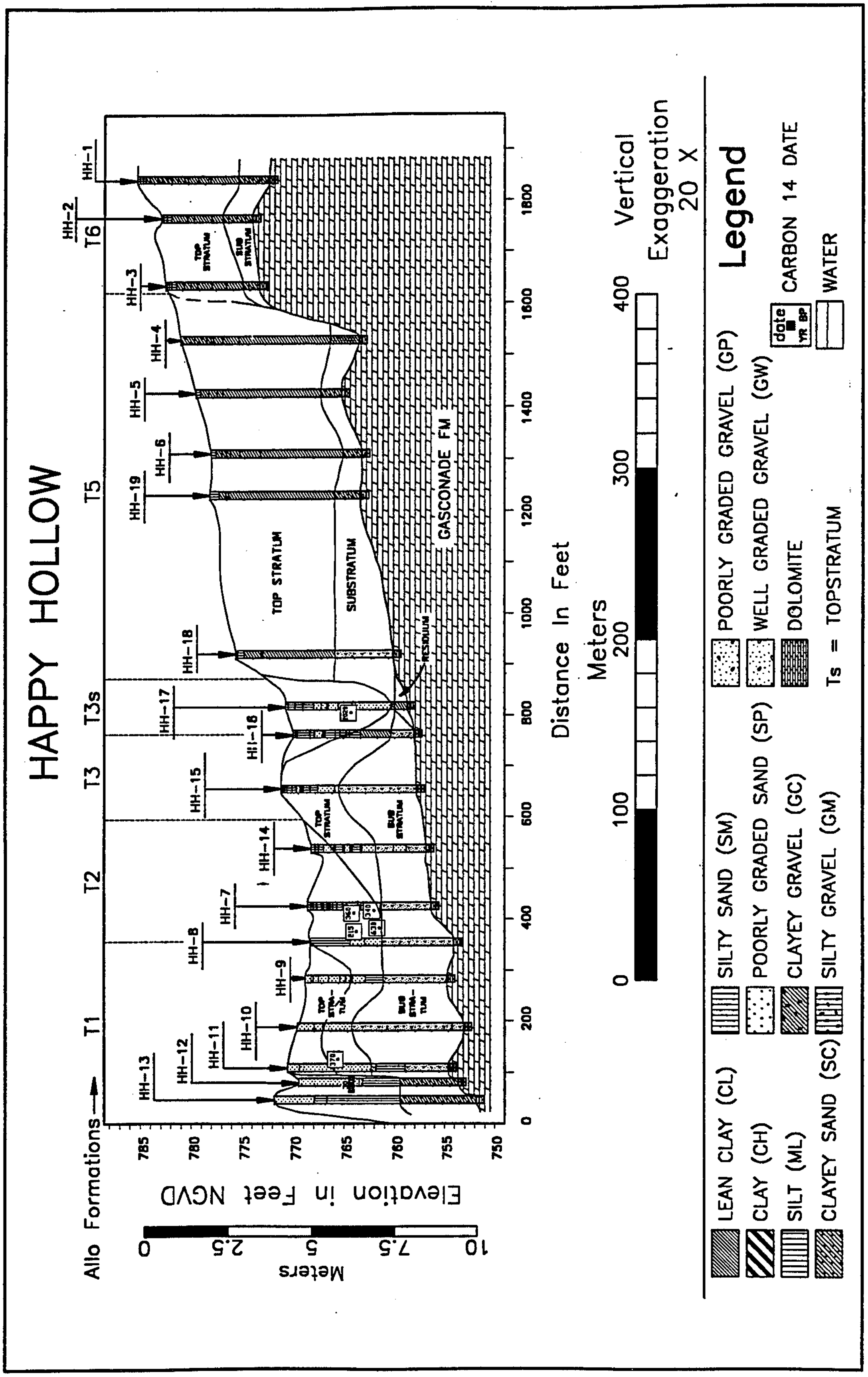


Figure 24. Interpreted section of the Big Piney at Happy Hollow

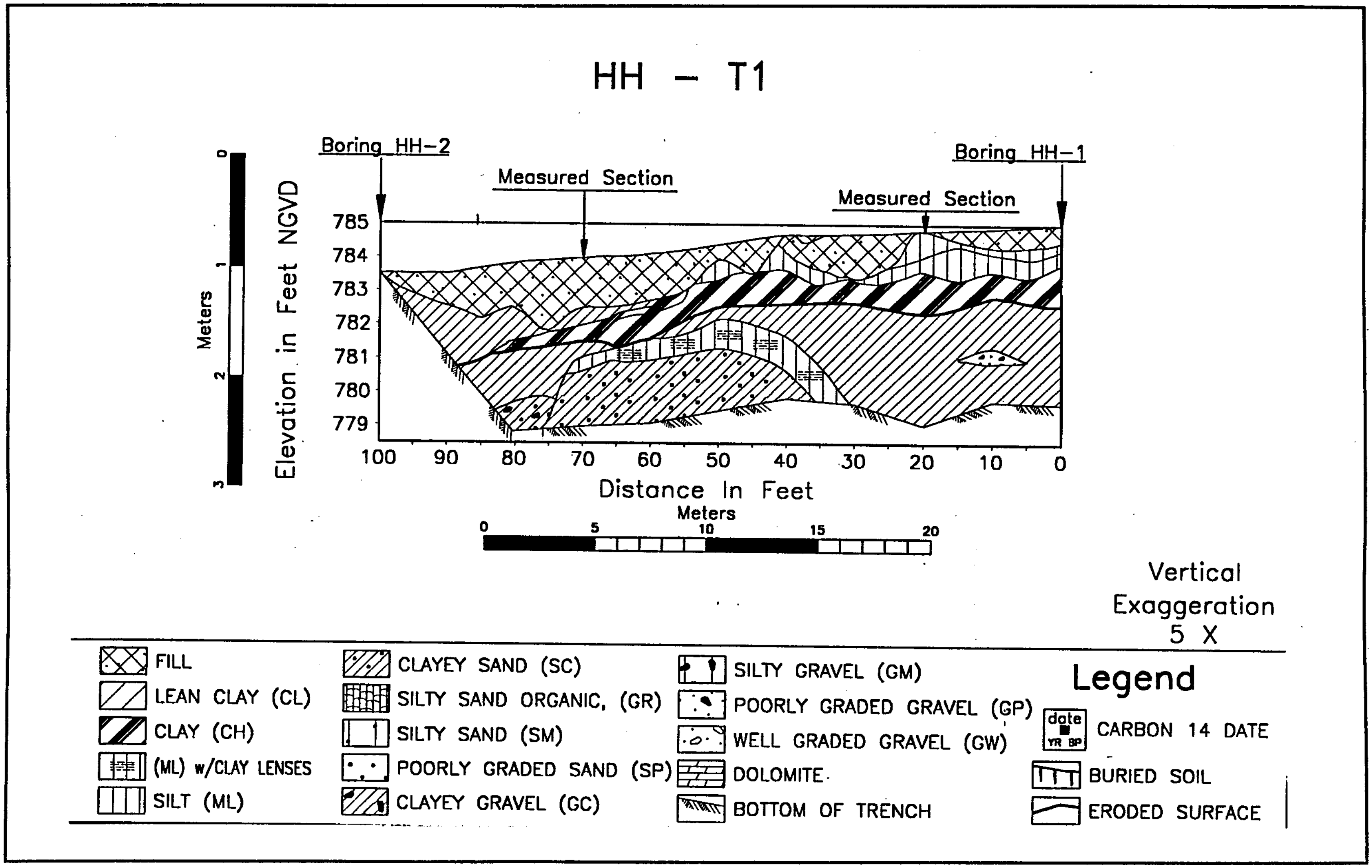


Figure 25. Trench HH T1 for the Big Piney at Happy Hollow site

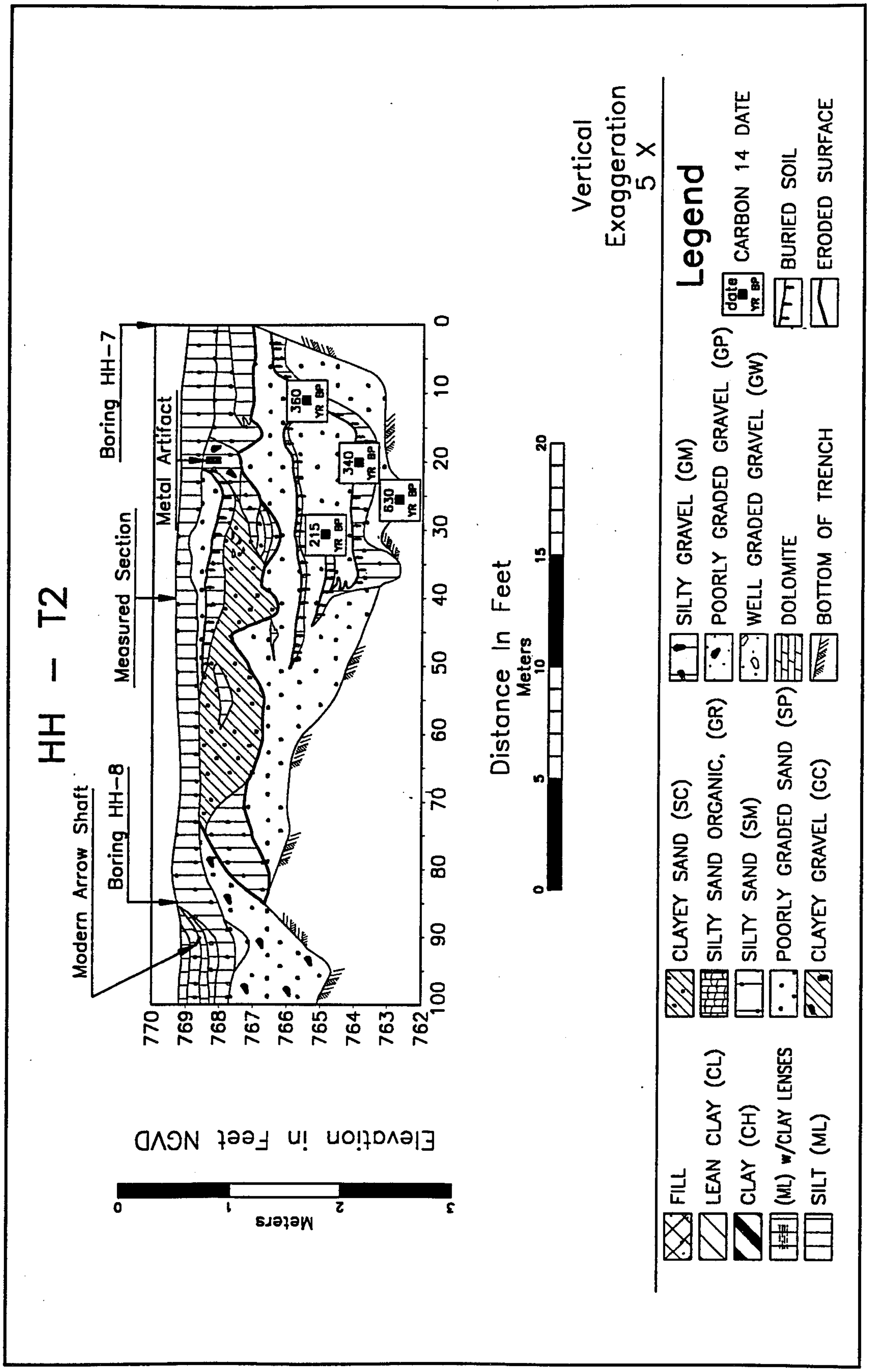


Figure 26. Trench HH T2 for the Big Piney at Happy Hollow site

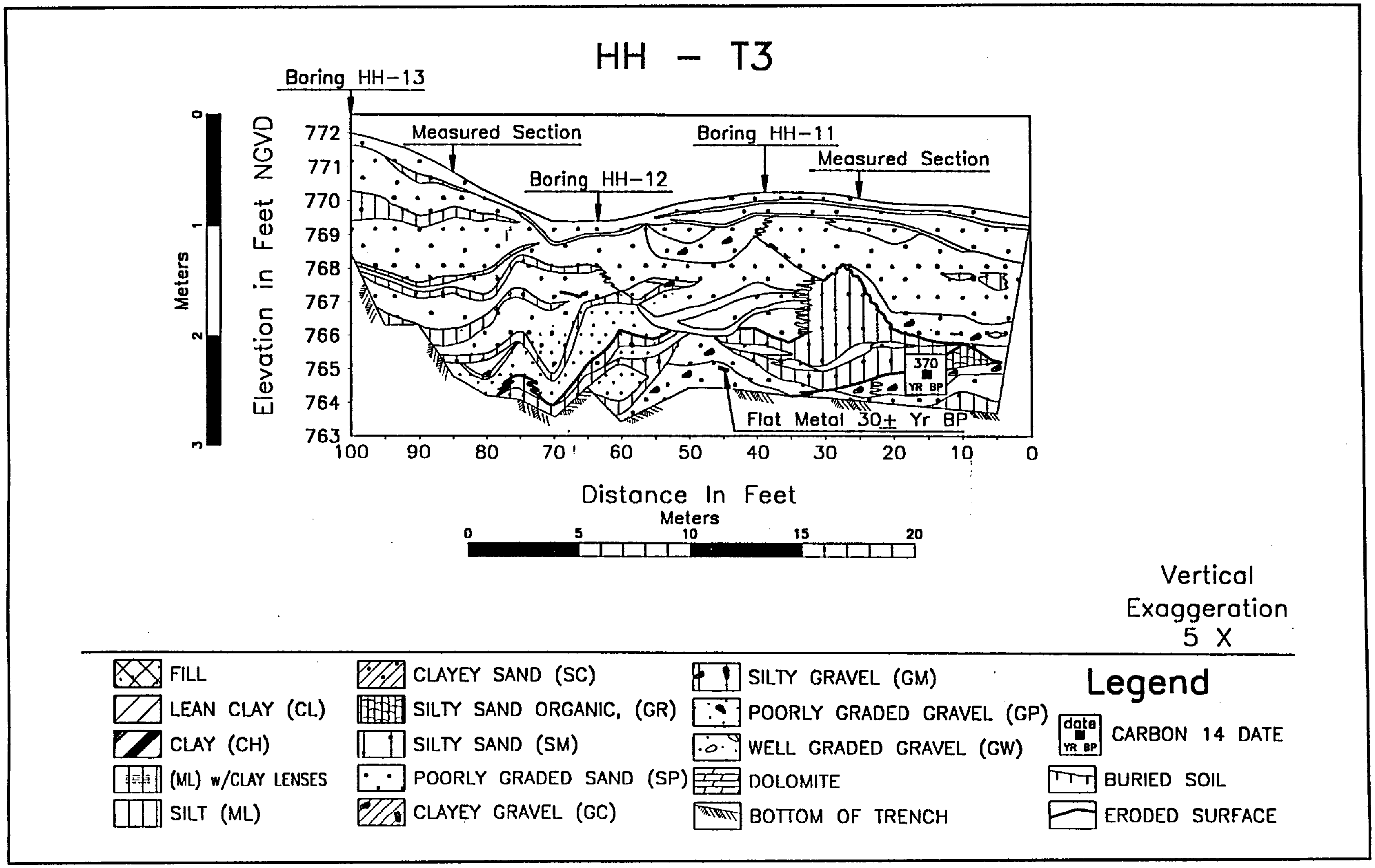


Figure 27. Trench HH T3 for the Big Piney at Happy Hollow site

exercises. Trench HHT-1 indicates a strong clay soil. The clay sand (SC) and SC with gravel suggests colluvial infilling derived upslope from Roubidoux residuum. No carbon enriched sediments or charcoal were found to age date this section. The heavy clay enriched soil and lack of carbon suggests that this is an "old" stable surface. The SCS mapped this as Hartville. Soil geomorphic mapping later denoted this unit as the T6 Ousley Springs formation.

Borings HH-4, 5, 6, 19, and 18 (Figure 24) encountered similar soil conditions except the clay sequence is thicker and bedrock is deeper. A wetland has developed in the poorly drained area between borings HH-18 and 19. Due to the wetland we were unable to trench this surface. Wolf (1989) mapped this unit as the Moniteau. Subsequent soil geomorphic mapping delineated this surface as the T5w Miller wet formation. A contact is drawn (Figure 24) between boring HH-17 and 18 based on break in slope and change in lithology. The slough at the toeslope, which is dated at 2,020 years B.P. consists mapped as T3s, of interbedded silt and sand as indicated by borings HH-16 and 17, and the surface penetrated by borings HH-14, 15, and 16 represents a late Holocene terrace, designated as the T3 Dundas.

The sediments near the river's edge are natural levee with underlying point bar deposits. Trenching through this surface unearthed metal artifacts in trench HH-T2 and HH-T3 (Figures 26 and 27). The presence of the metal artifacts indicates modern disturbance of the area. The lack of soil development indicates recent deposition of the area near the river. C^{14} dates from trench 2 reveal age dates of 630 to 215 years B.P. Closer examination of trench HH-T2 (Figure 26) shows buried A horizons containing the carbon which was dated. The sediment/soil sequence indicates deposition with pedogensis followed by renewed deposition and pedogensis. This prehistoric floodplain unit was later designated as T2 Ramsey. Trench HH-T3 (Figure 27) also revealed the stacked sequence of buried A horizons. The C^{14} date derived from organic silts in trench HH-T3 gave a date of 370 years B.P. Also the metal artifact buried 5 ft in the ground indicates modern reworking near the river's edge. The modern and historic sediments with little to no soil development were designated the T1 and named Happy Hollow after the site of the trenching.

The soil-geomorphic analysis of the Big Piney reach at Happy Hollow reveal allostratigraphic units (from oldest to youngest) T6, T5w, T3, T2, and T1. The T1 Happy Hollow formation identified and named for this study area is historic in age. Soil profile development in the terrace soil collaborate the age relationships with the T6 and T5 being alfisols, T3 being mollisols and T2 and T1 being entisols. The transect is typical of the Big Piney River cultural resource zone. The Big Piney River is a gaining Ozark stream with the common slanted terraces preserved. The valley fill consists of a gravelly substratum overlain with a finer grained topstratum. Historic sediments are coarser grained than the prehistoric sediments.

Lower Roubidoux

The Lower Roubidoux cultural resource management zone was investigated less than a mile south of the military boundary (Figure 28). The big valley perspective is portrayed in Figure 29 with 20 times vertical exaggeration to emphasize the bedrock bluffs. Borings and trenches at the site are laid out as shown in Figures 30, 31, and 32. The interpreted transects are presented in Figures 33 and 34. The lower Roubidoux transect differs from the previous Big Piney section in that it is relatively flat except its undulating meander scrolls. Also the thickness of substratum gravels is greater than the on the Big Piney. The carbon dates reveal deposition in three episodes: approximately 4,500, 4,000, and 1,400 years B.P. Therefore, based on the dates and geomorphic expressions, this section was differentiated into four units. The modern gravel bars are designated as T0 Cookeville. The next unit to the right with a date of 1,370 years B.P. is T2 Ramsey. The next terrace, T4 Quesenberry, is attached to the T5 Miller.

Interpretation of the cross-sections and trenches at Lower Roubidoux follows. Borings R5 through R10 are situated on the T5 Miller surface (Figure 33) as evidenced by the occurrence of the silty fine-grained material. Near the upland sideslope and associated with boring R9 is a feature designated as a slough (T5s) and presently interpreted as being a prehistoric channel, then an overflow channel until complete abandonment. The substratum material would have been removed during the formation of this feature and then later filled with the silty material of T5 age. Between borings R4 and R5 there appears to have occurred a change in lithology, decease in pedologic development, a slight drop in elevation, and a decrease in the radiocarbon age. The soil material goes from being dominated by silt in boring R5 to being of equal portions or sand dominated in boring R4. This change in lithology, elevation and radiocarbon age led to the differentiation of T4 alloformation from T5. This same process occurs again between borings R2 and R3, and R1 and R2. The surfaces separated here represent the T2 and T0 alloformations. The cross section (Figure 33) is a good example of a meandering stream depositing point bars and later depositing a sequence of overbank material which fines upward.

Trench LR-T1 (Figure 35) reveals the contact between the T2 and T4. Trench LR-T1 also portrays the complexity of fluvial sediments. Both in the area of boring R2 and R3 coarser material is deposited as a point bar in the lower portions of the trench. Figure 35 illustrates the fining up sequence common to fluvial systems. In the lower surface of boring R2 a buried surface is present which may record a period of aggradation within the stream system and subsequent deposition on this surface.

Trench LR-T2 (Figure 36) provides a close up view of the undulating surface and underlying silt which dates around 4,500 years B.P., named the T5 Miller formation. Examination of trench LR-T2 reveals the underlying gravel substratum beneath the thick topstratum of silty clay and silt. The trench also, revealed fire cracked rock in the plow zone indicating archaeological site potential to 1 ft (30 cm). LR-T2 represents a period of vertical

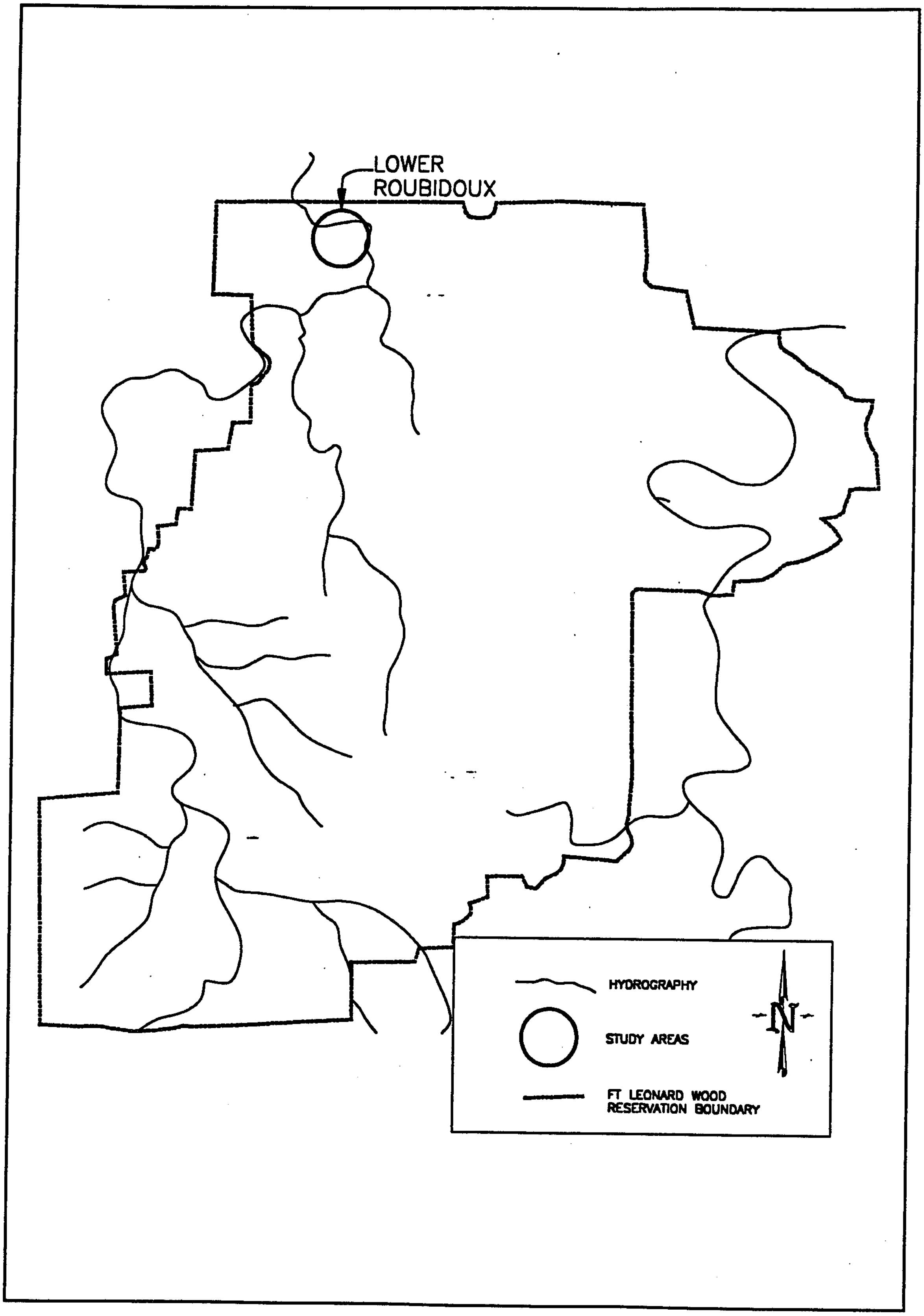


Figure 28. Location map of the Lower Roubidoux

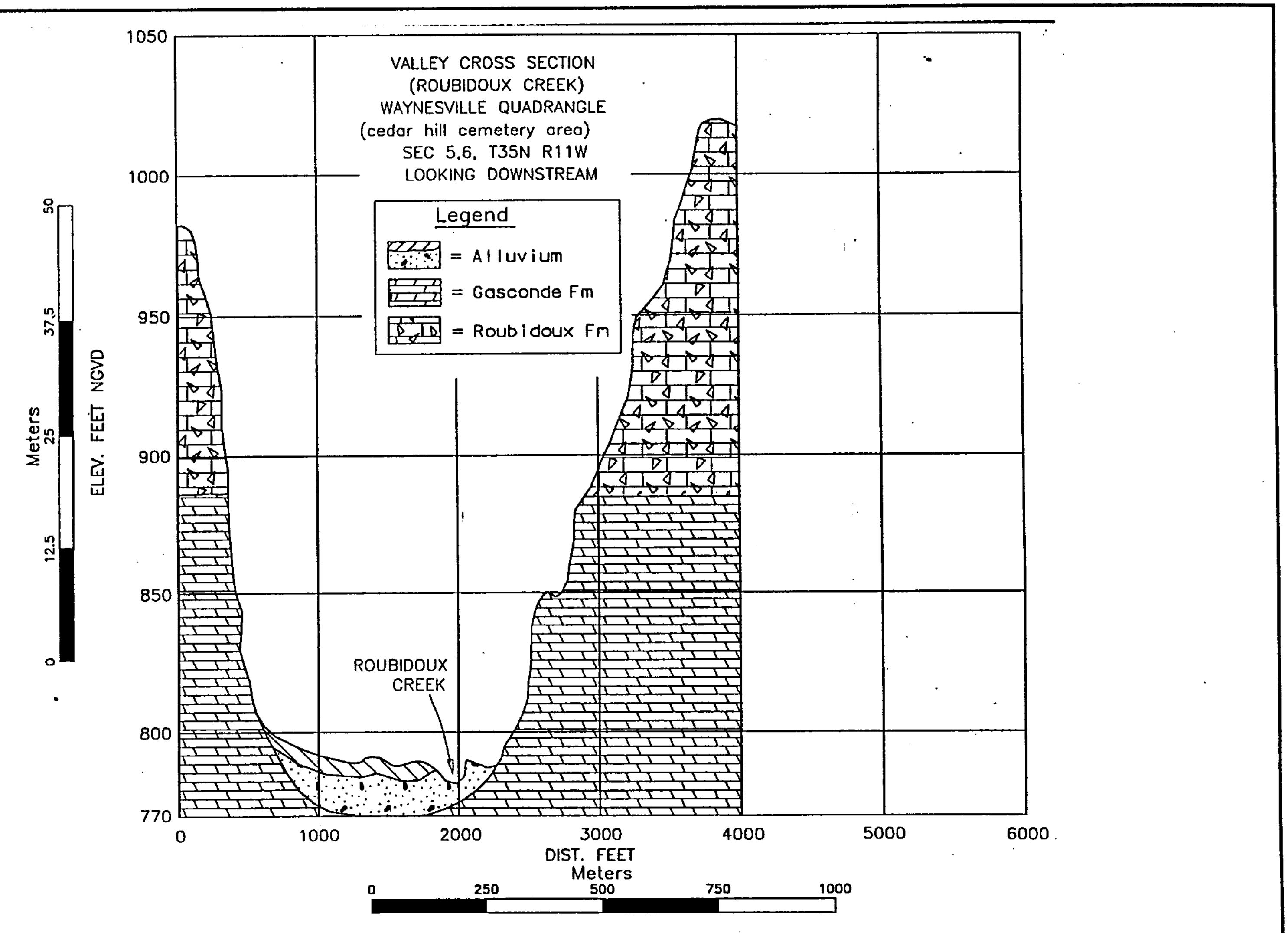


Figure 29. Valley cross-section of the Lower Roubidoux near Cedar Hill Cemetery

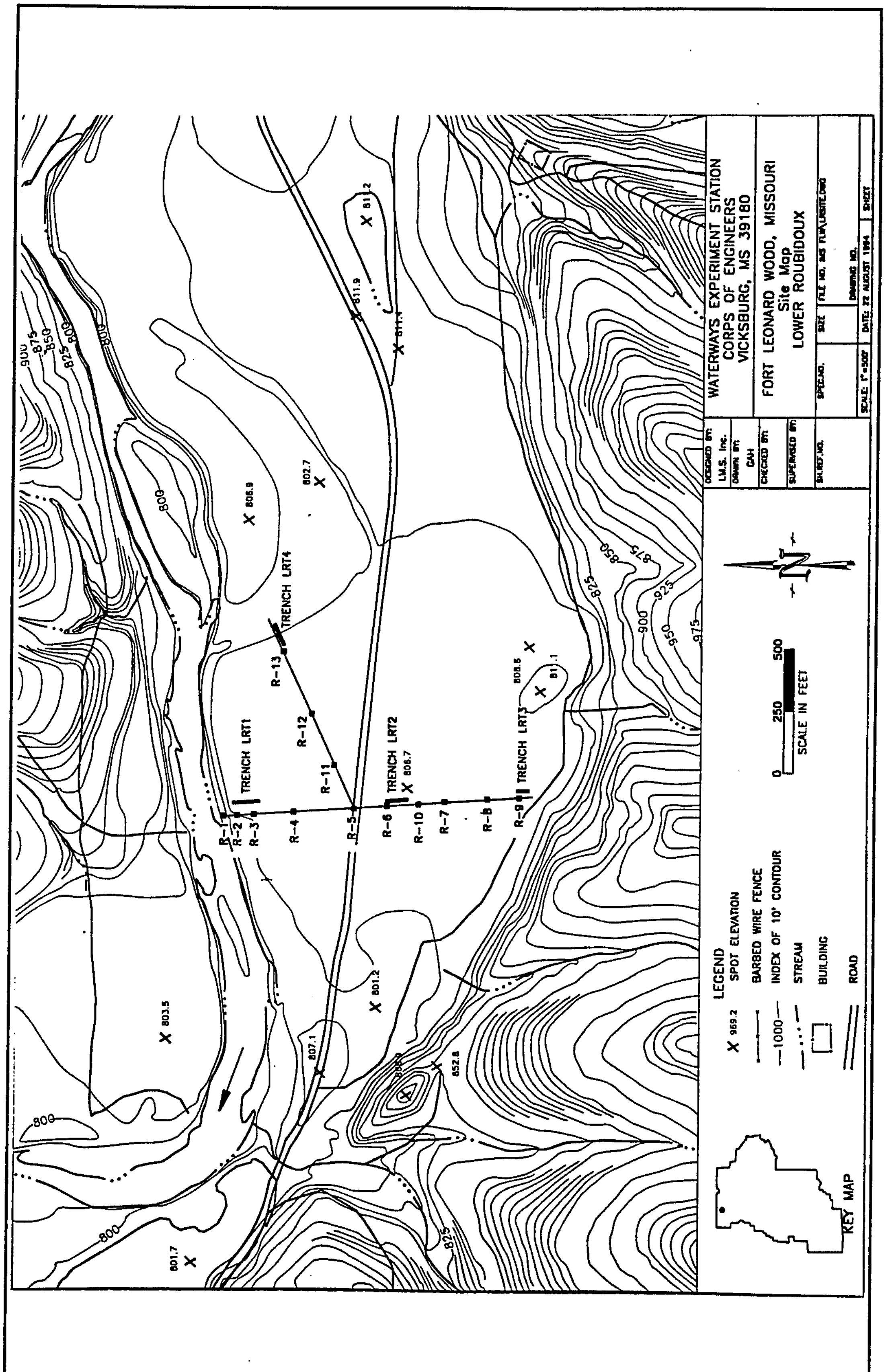


Figure 30. Location map of Lower Roubidoux transect of borings and trenches

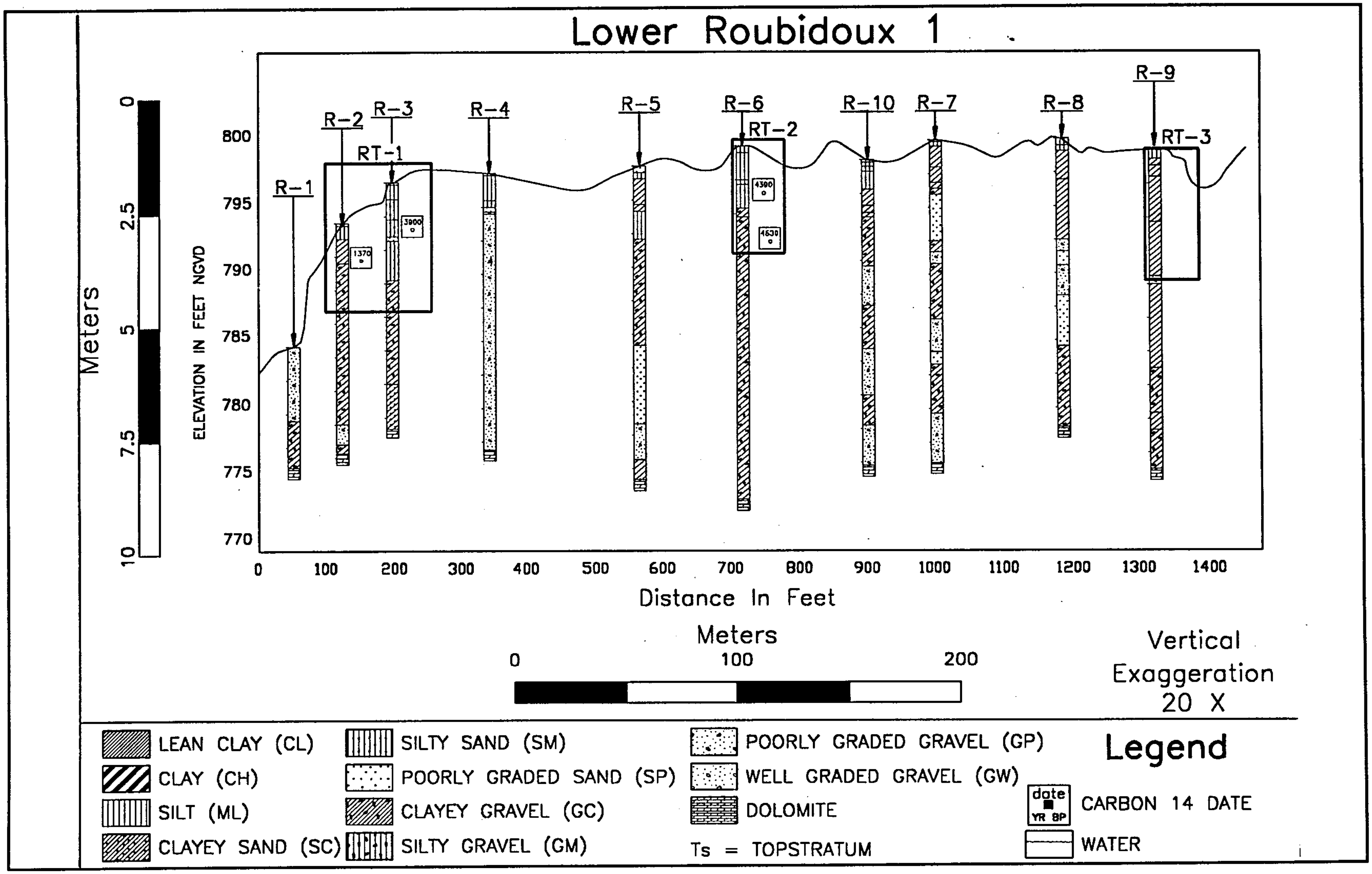


Figure 31. Location of Lower Roubidoux transect of borings and trenches data

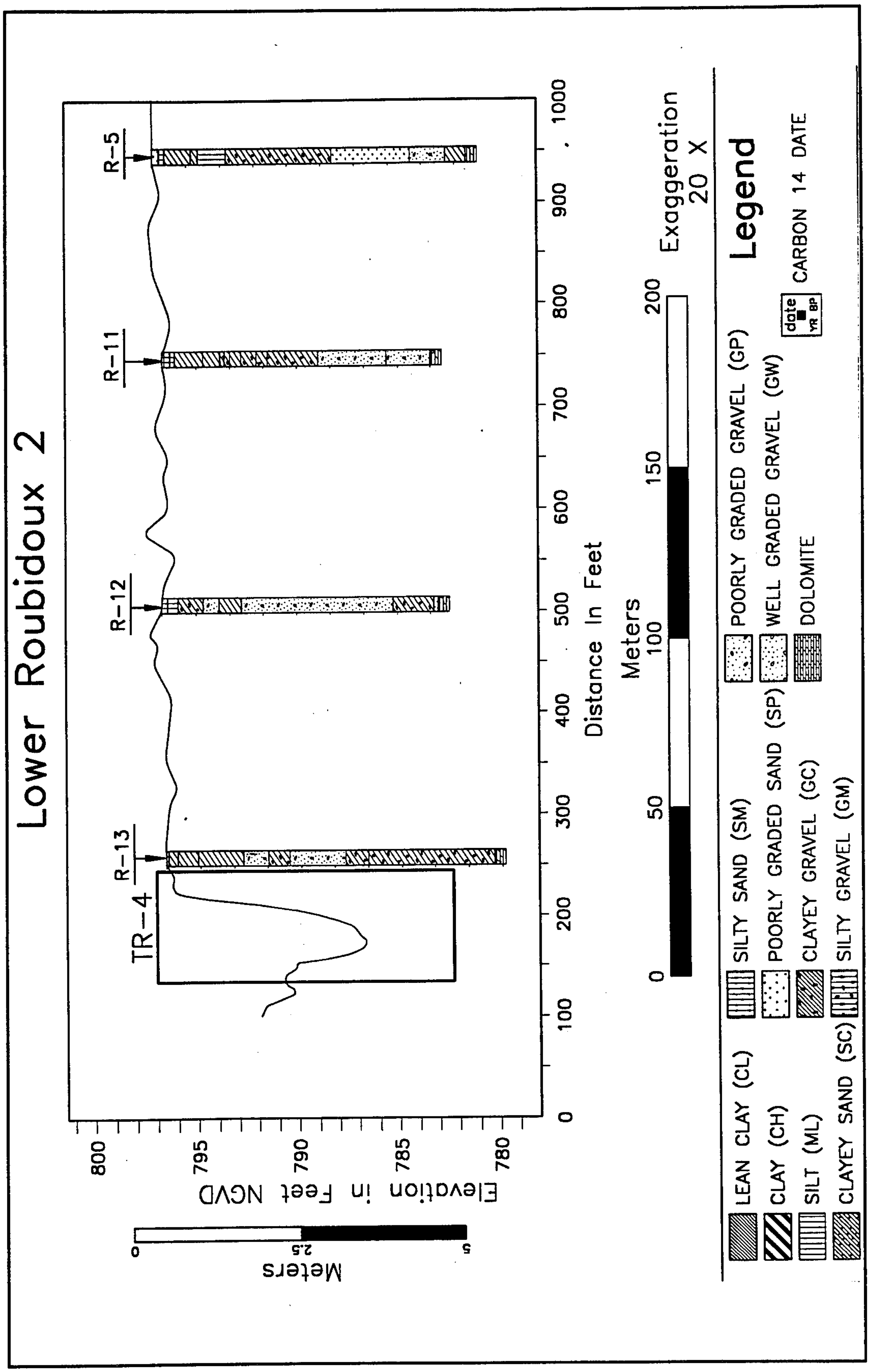


Figure 32. Location of Lower Roubidoux transect of borings and trenches data

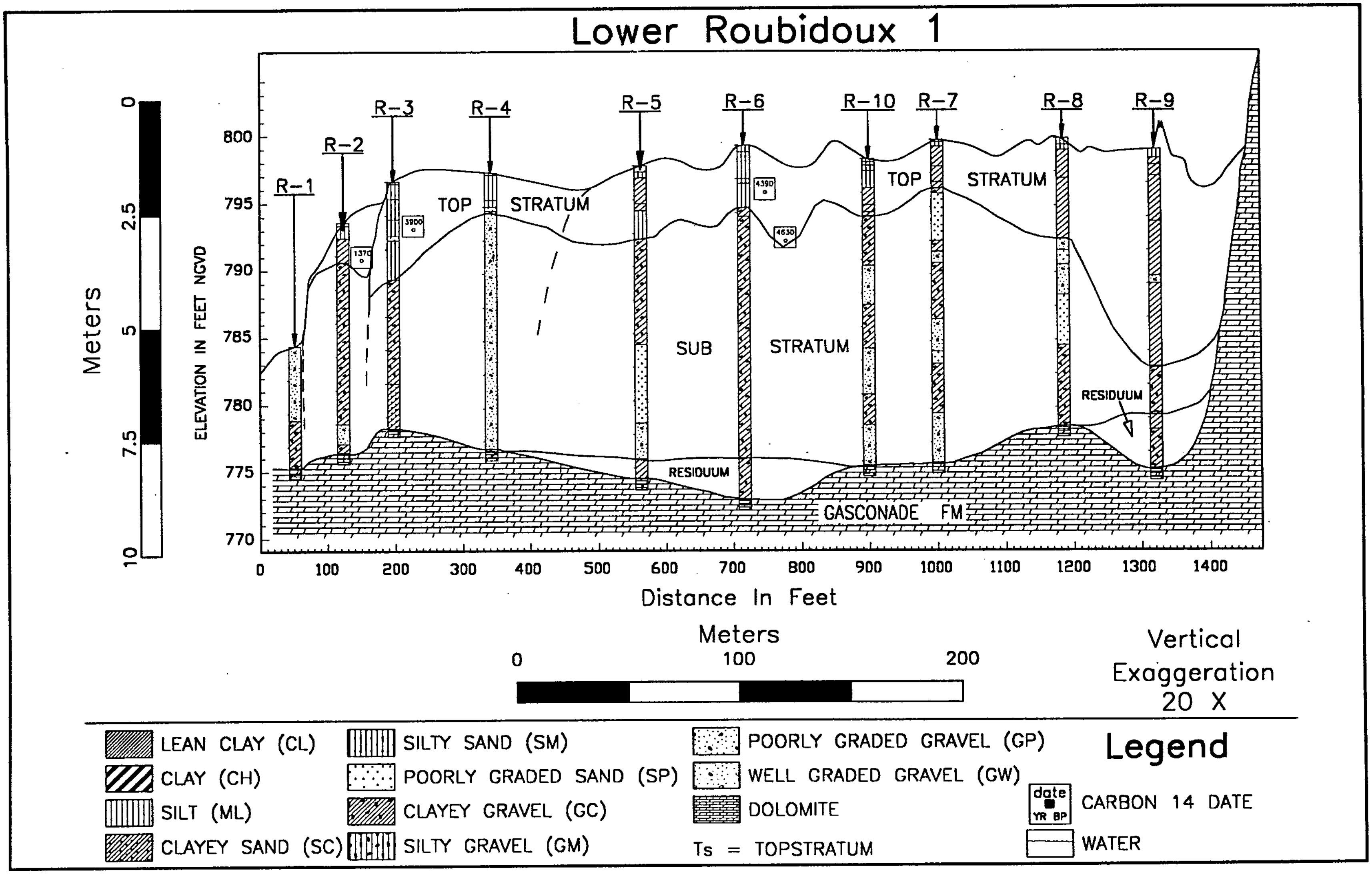


Figure 33. Interpreted section of Lower Roubidoux transect of borings and trenches data

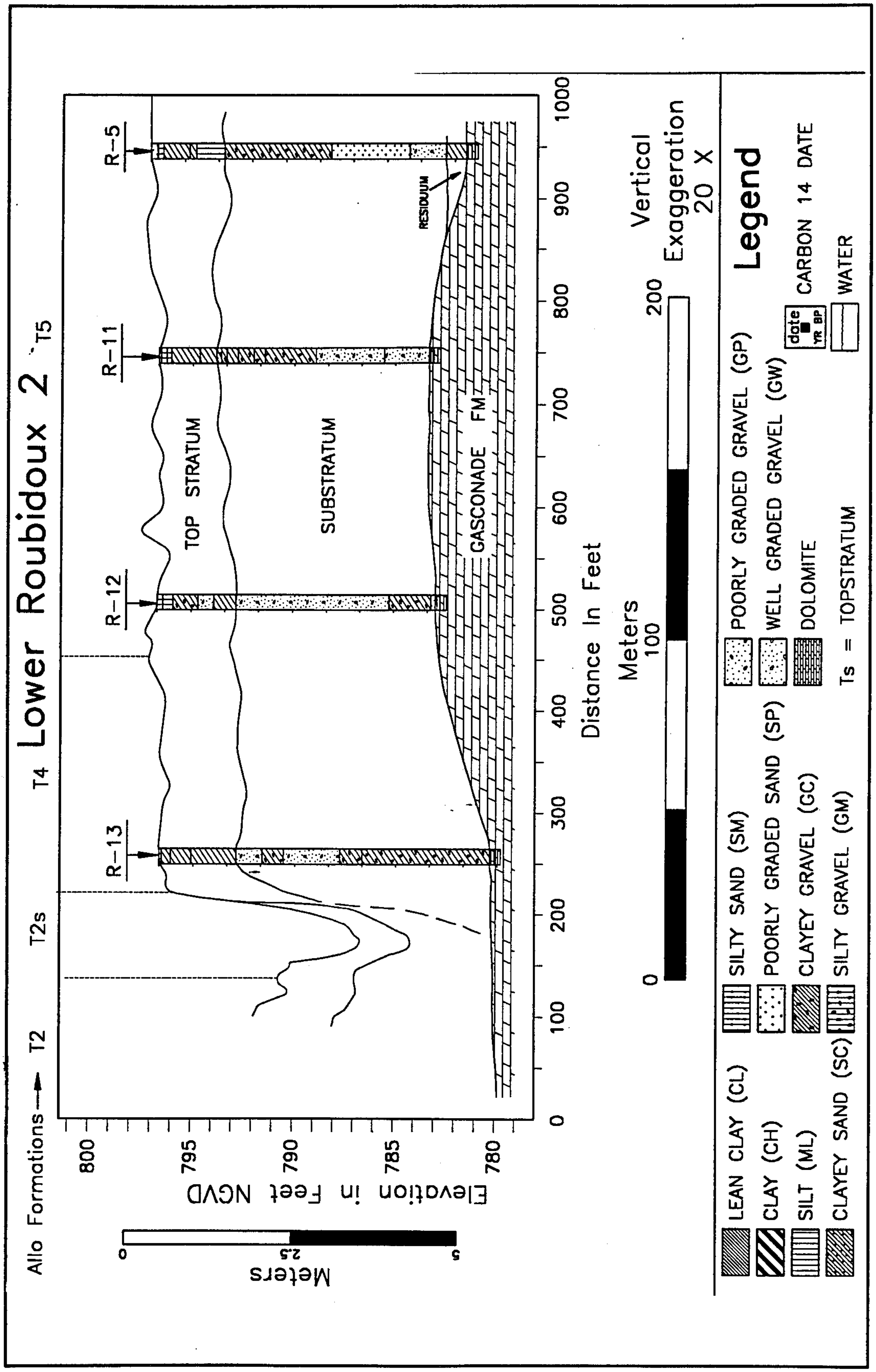


Figure 34. Interpreted section of Lower Roubidoux transect of borings and trenches data

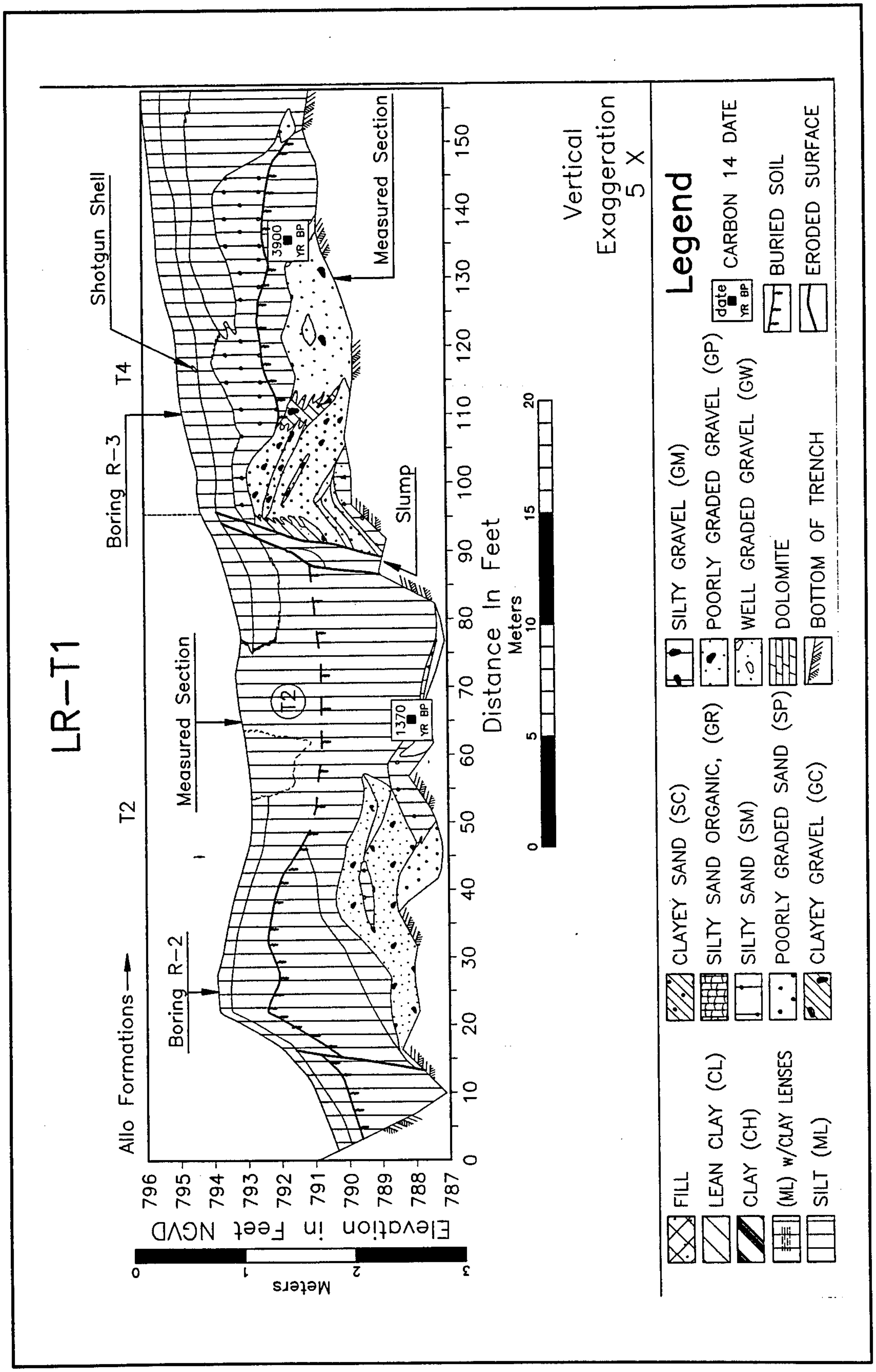


Figure 35. Trench LR-T1 of the Lower Roubidoux

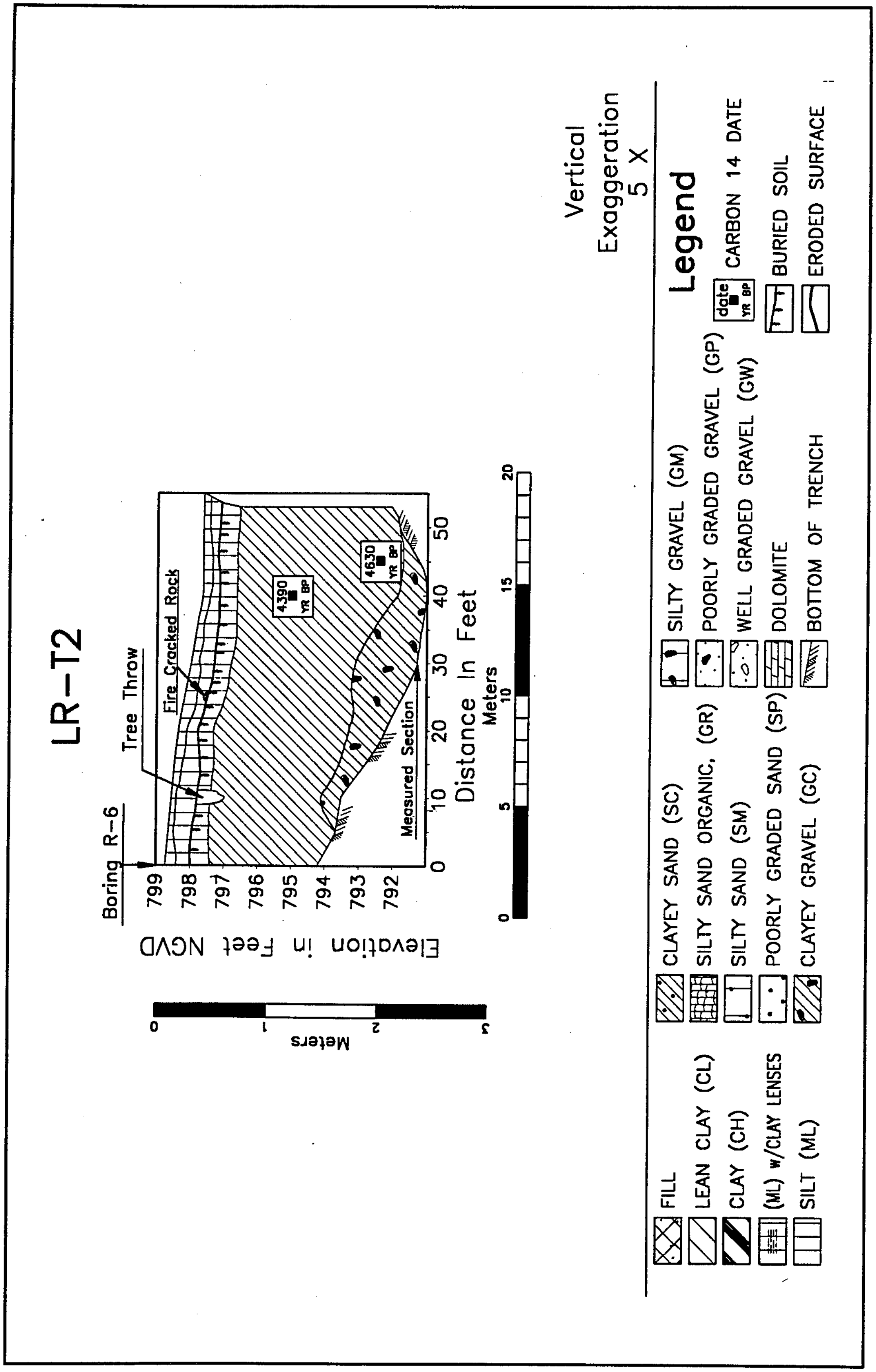


Figure 36. Trench LR-T2 of the Lower Roubidoux

accretion of silty material. This is indicative of a consistent source material, such loess reworked from the hillslopes. Radiocarbon data suggested that this material was not deposited at one time but in small increments over time.

The slough against the valley wall was designated T5s. Trench LR-T3 was excavated as shown on Figures 30 and 31 but was not measured in detail. Examination of the trench did not reveal a distinct contact or change in material such as clay or organics.

A second transect consisting of borings 11, 12, and 13, and trench LR-T4 was conducted across the floodplain to test the contact with the lower surface and slough. Trench LR-T4 (Figure 37) showed a sharp contact with the slough and terrace T4. The lower surface was later designated T2 Ramsey. Figure 37 illustrates a strong escarpment marking the boundary between an older and younger surface. As the stream downcuts below the older surface, a point bar was deposited on the inside of the meander. This channel was later abandoned and now the stream is on the other side of the point bar. After abandonment finer materials were deposited in the abandoned meander. Even later, younger material was deposited over both the point bar and slough as vertical accretion.

The soil-geomorphic investigation determined that the lower Roubidoux was filled with a thick gravel substratum covered with silt. The T5 Miller formation and T5s slough dominate this portion of the valley. T2 Ramsey and T2s slough are also present in this reach of the Roubidoux.

Upper Roubidoux

The Upper Roubidoux site (Figure 38) is situated in the southern portion of the fort. This reach of the creek is a gaining stream and therefore its landscape is more similar to the Big Piney than the lower Roubidoux Creek which is a losing stream. The long perpendicular transect with borings and trench locations is presented in Figures 39 and 40. An interpreted section is presented in Figure 41. The trench insets on Figure 40 are presented as Figures 42, 43, 44, 45, 46, and 47.

Boring UR-1 and the upper portion of trench UR-T1 (Figure 42) encountered colluvium overlying residuum. Examining the fine-grained silt and silty clay profile above the colluvium a buried surface is revealed. The fine mantle is hypothesized to be a loess and/or reworked loess veneer. It is possible that the T7co surface is developed in the Loveland Loess and is therefore Sangamon in age with the Peoria Loess on top (Reams 1968). Figure 42 reveals that in UR-T1 the possible deposition of loess or reworked loess over a paleosol developed in the colluvium and alluvium. The upper loess material would be consistent over the entire surface, but the colluvium would mix with and grade into the alluvium as the surface distance increased away from the upland.

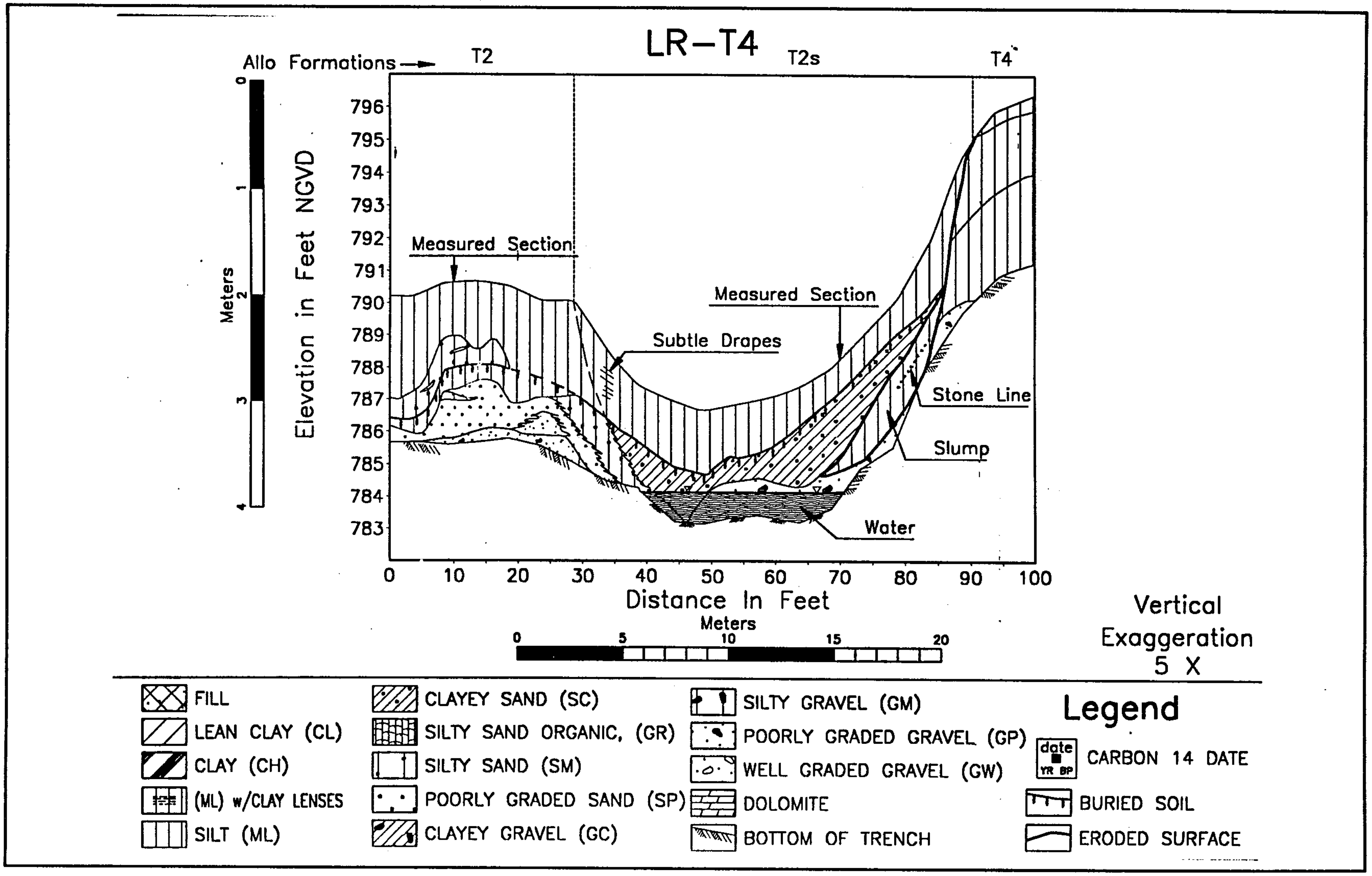


Figure 37. Trench LR-T4 of the Lower Roubidoux

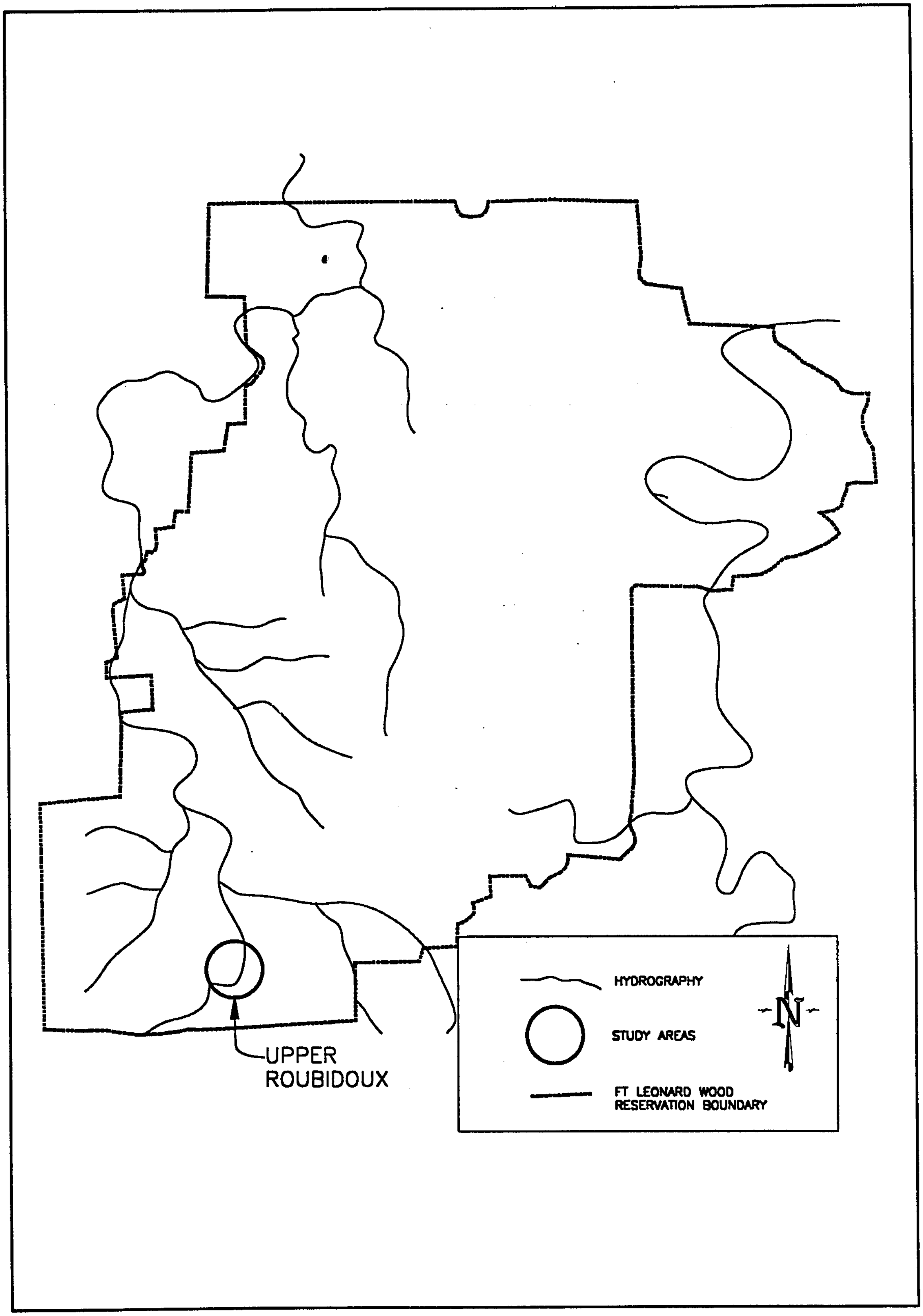


Figure 38. Location map of Upper Roubidoux study area

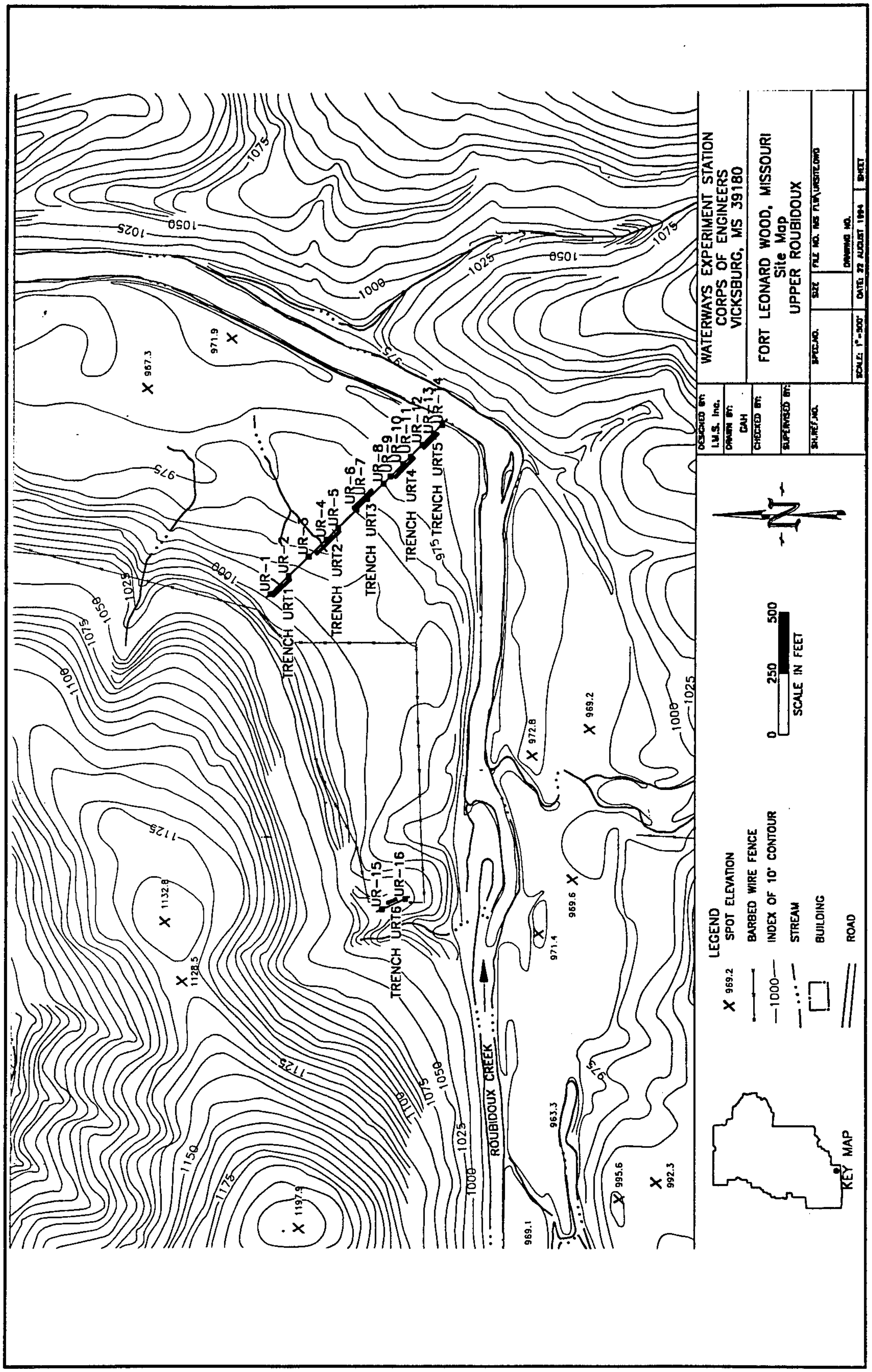


Figure 39. Location map of Upper Roubidoux transect of borings and trenches

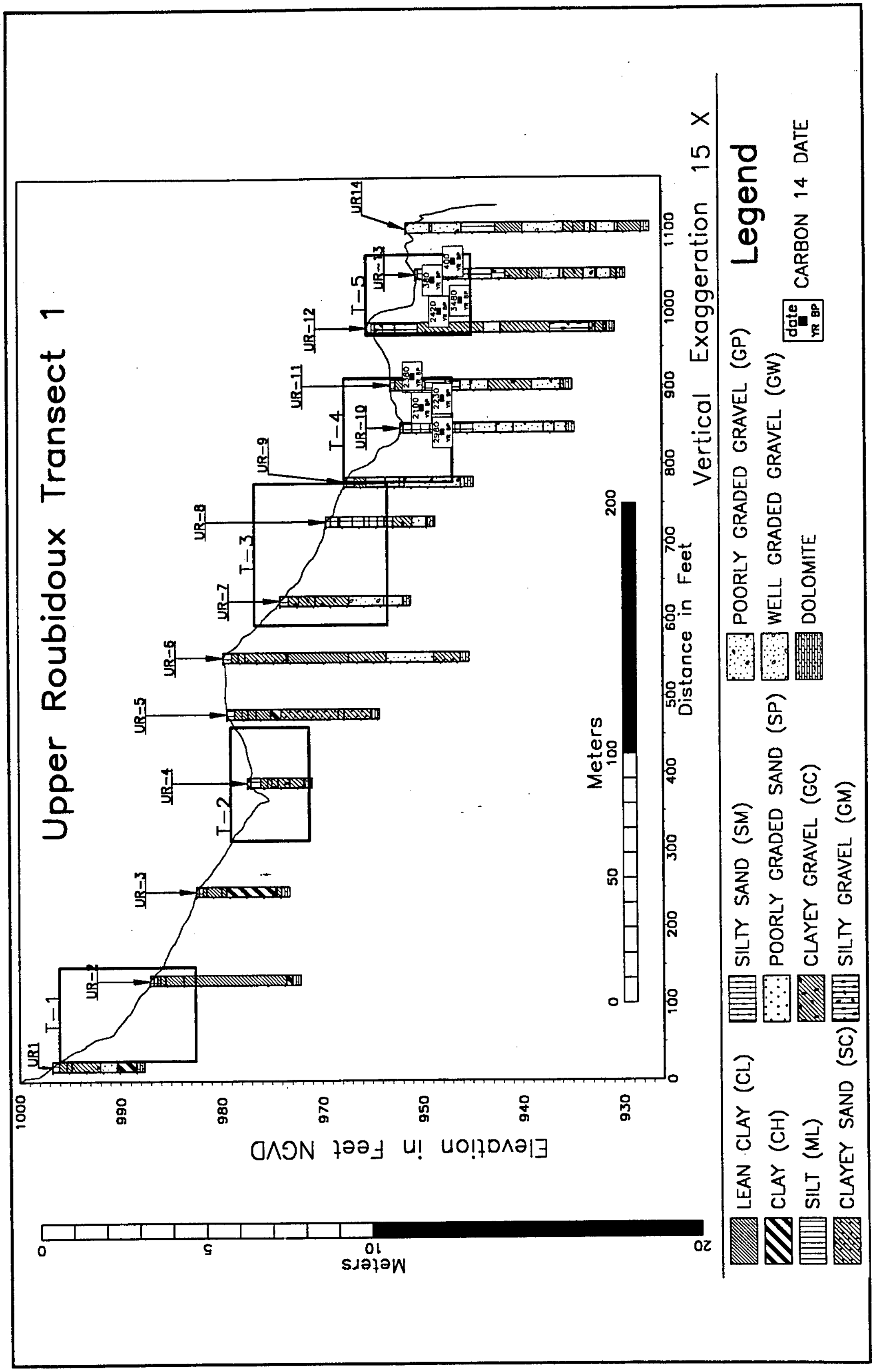


Figure 40. Transect of boring and trench data on the Upper Roubidoux

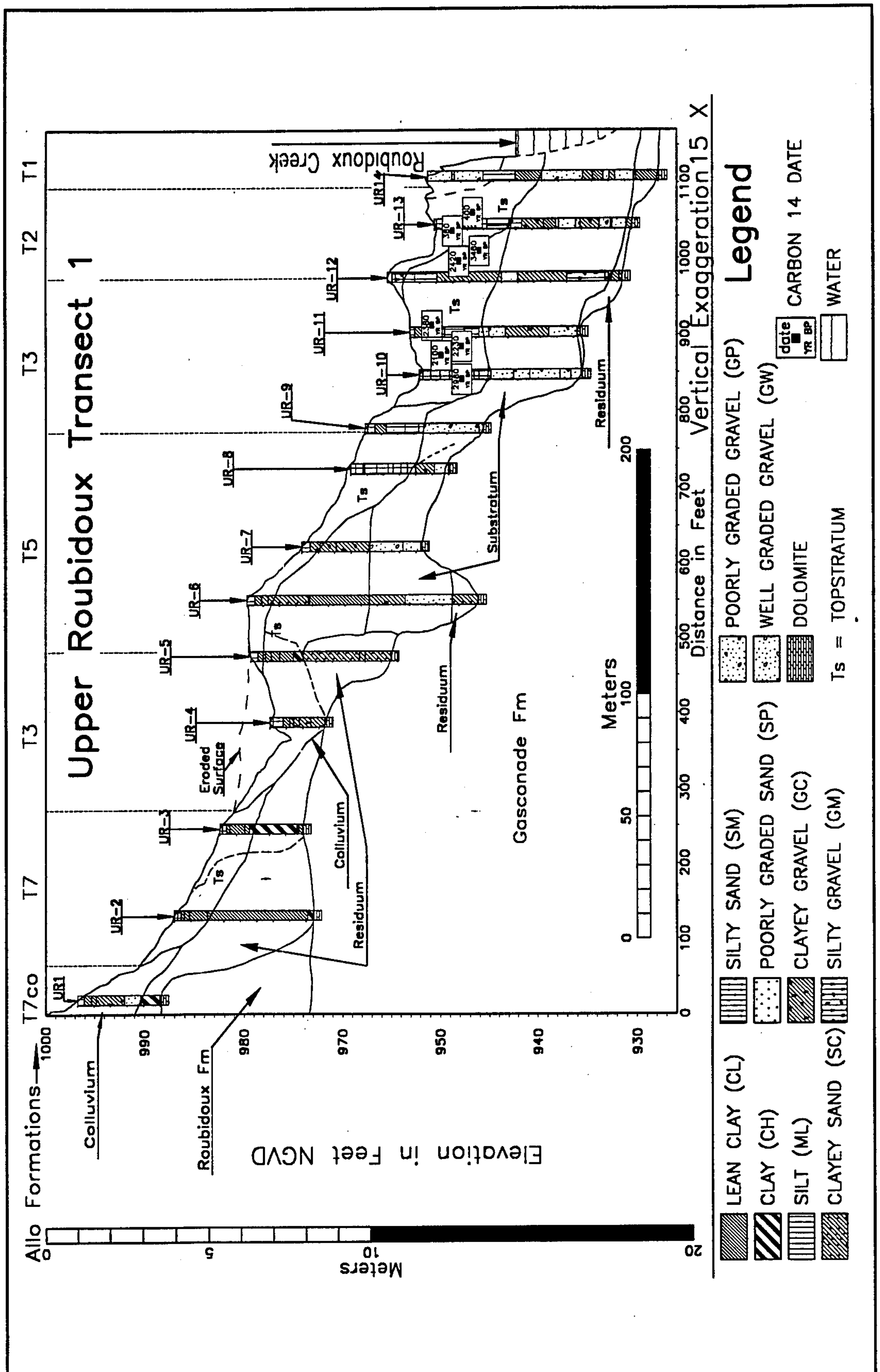


Figure 41. Interpreted section of Upper Roubidoux

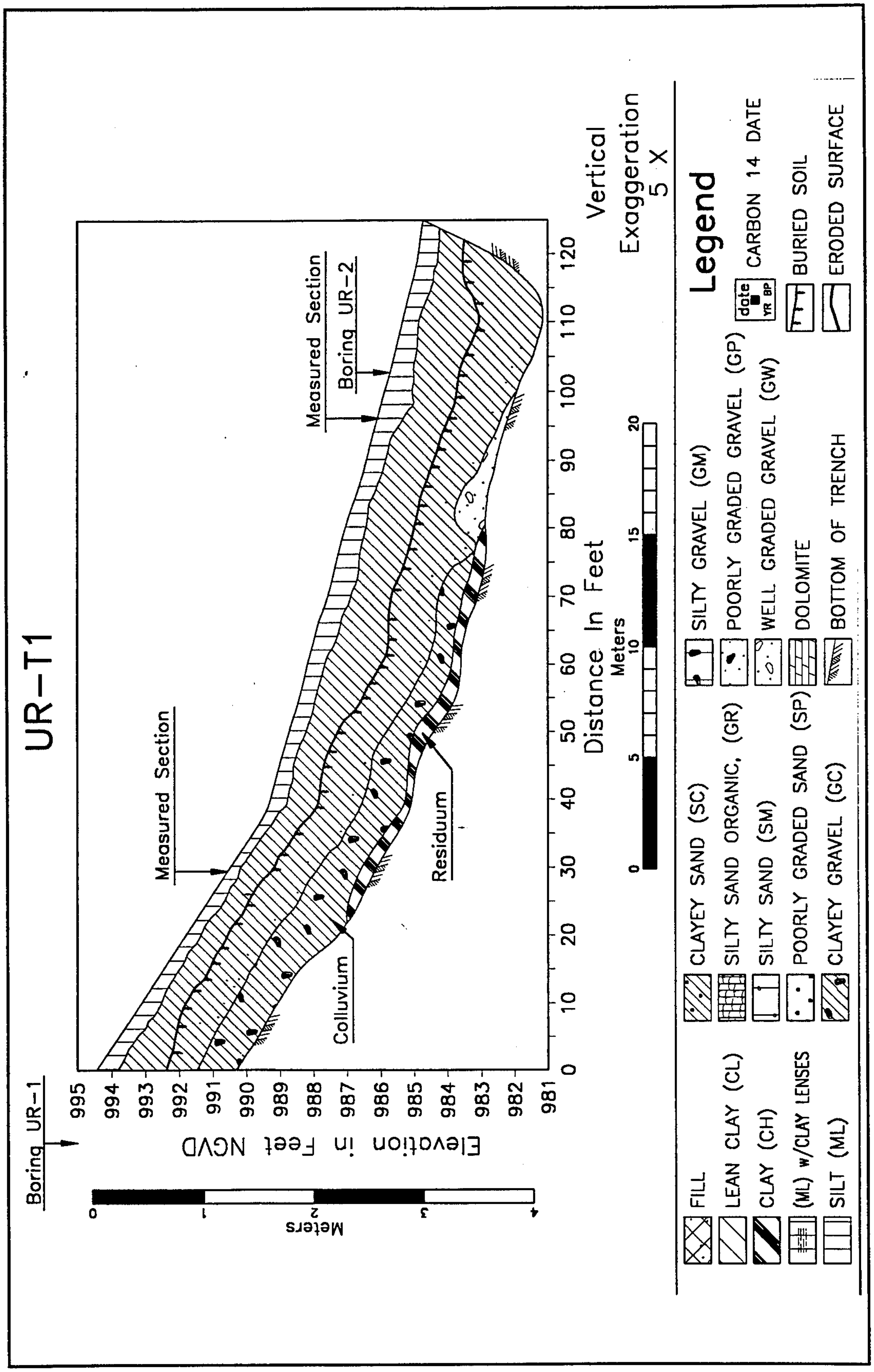


Figure 42. Trench UR-T1

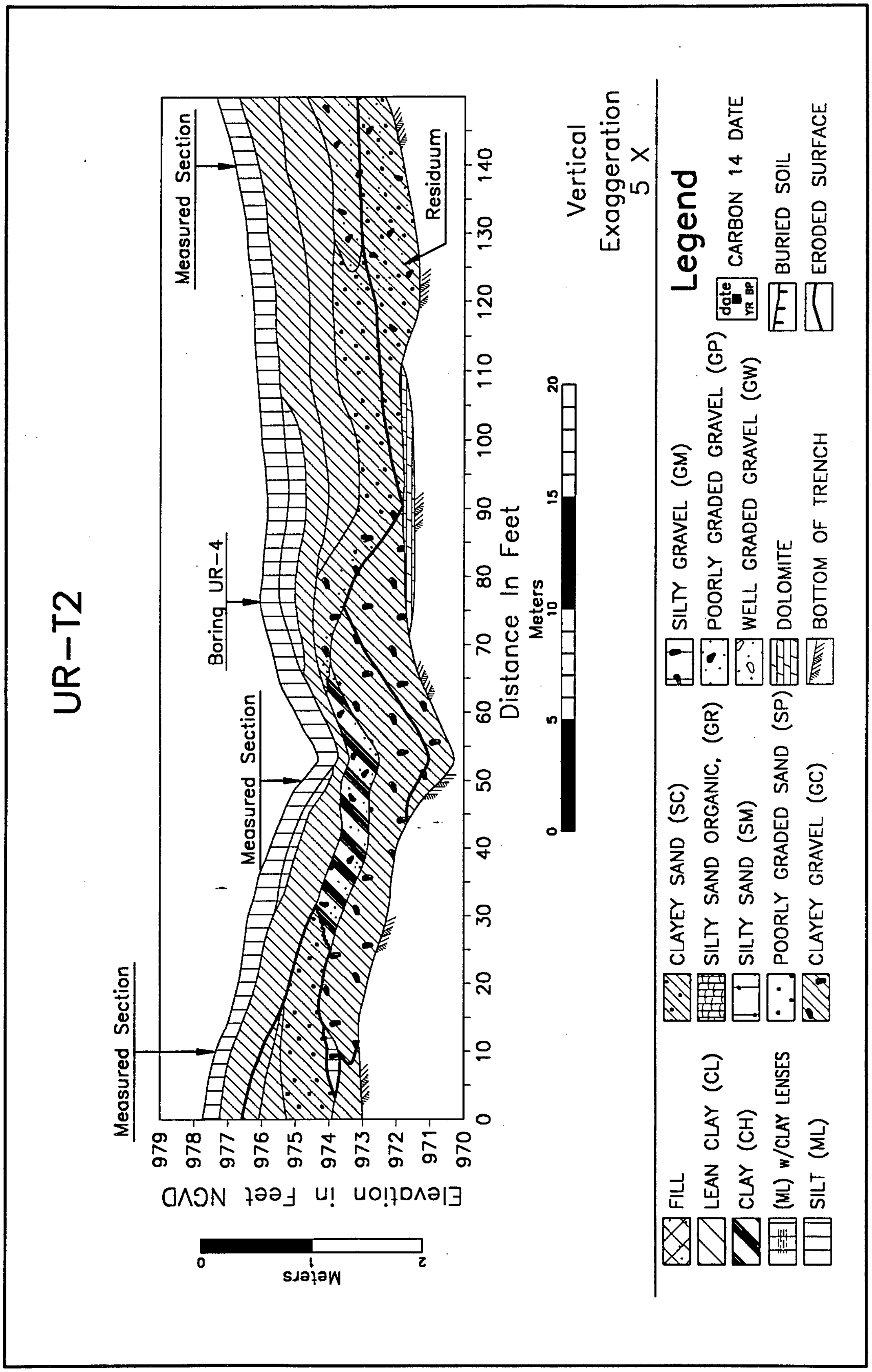


Figure 43. Trench UR-T2

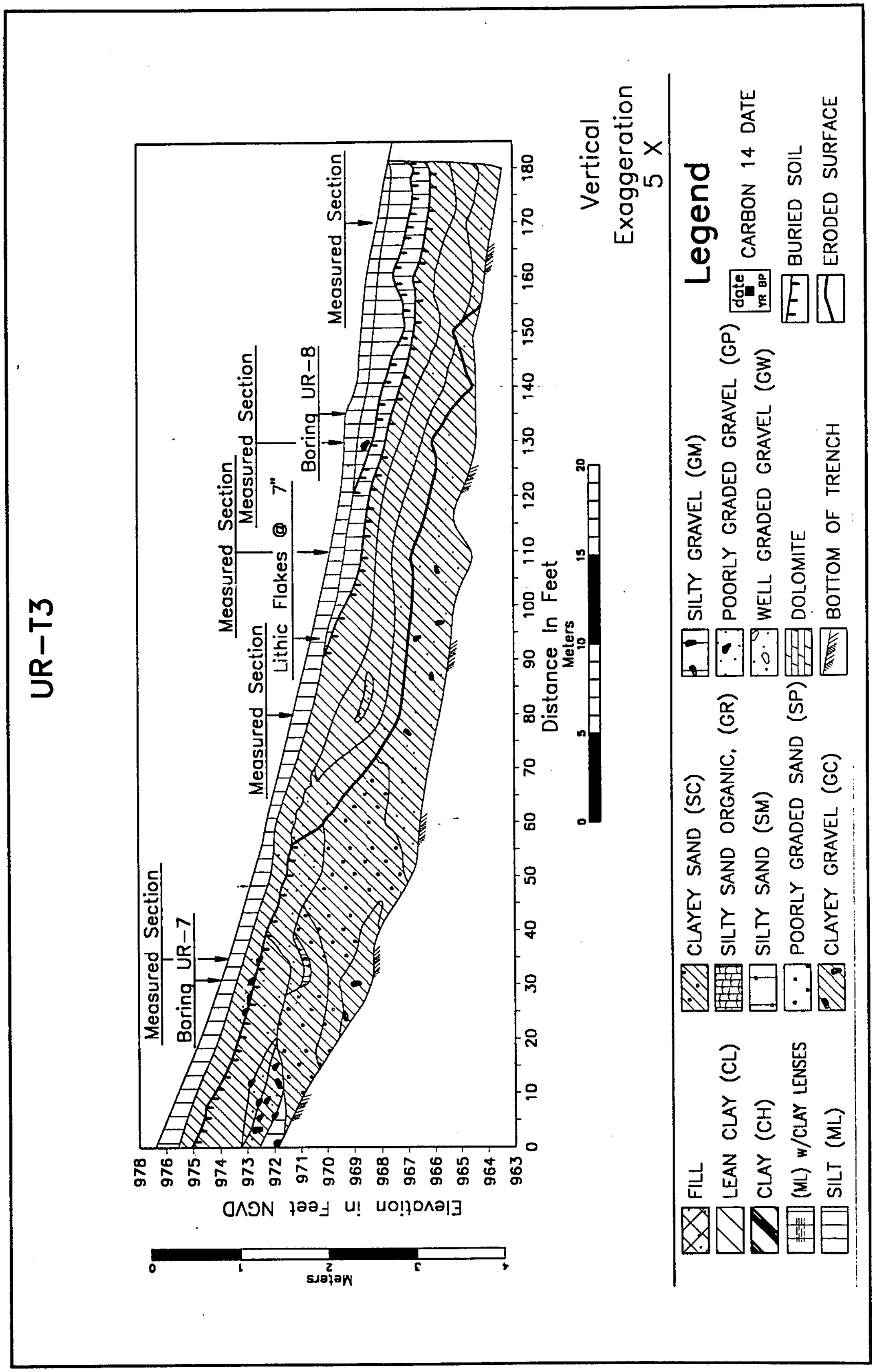


Figure 44. Trench UR-T3

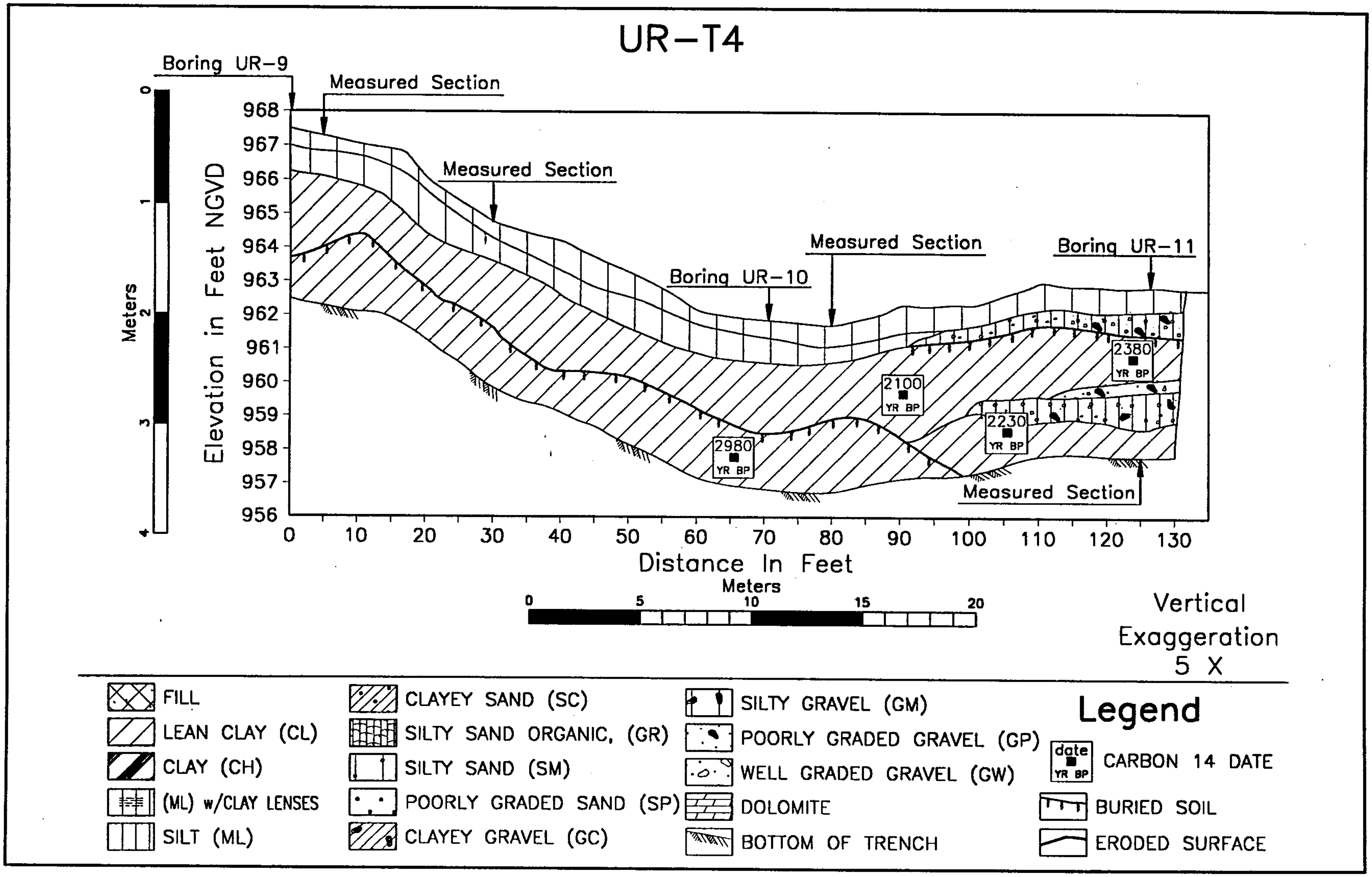


Figure 45. Trench UR-T4

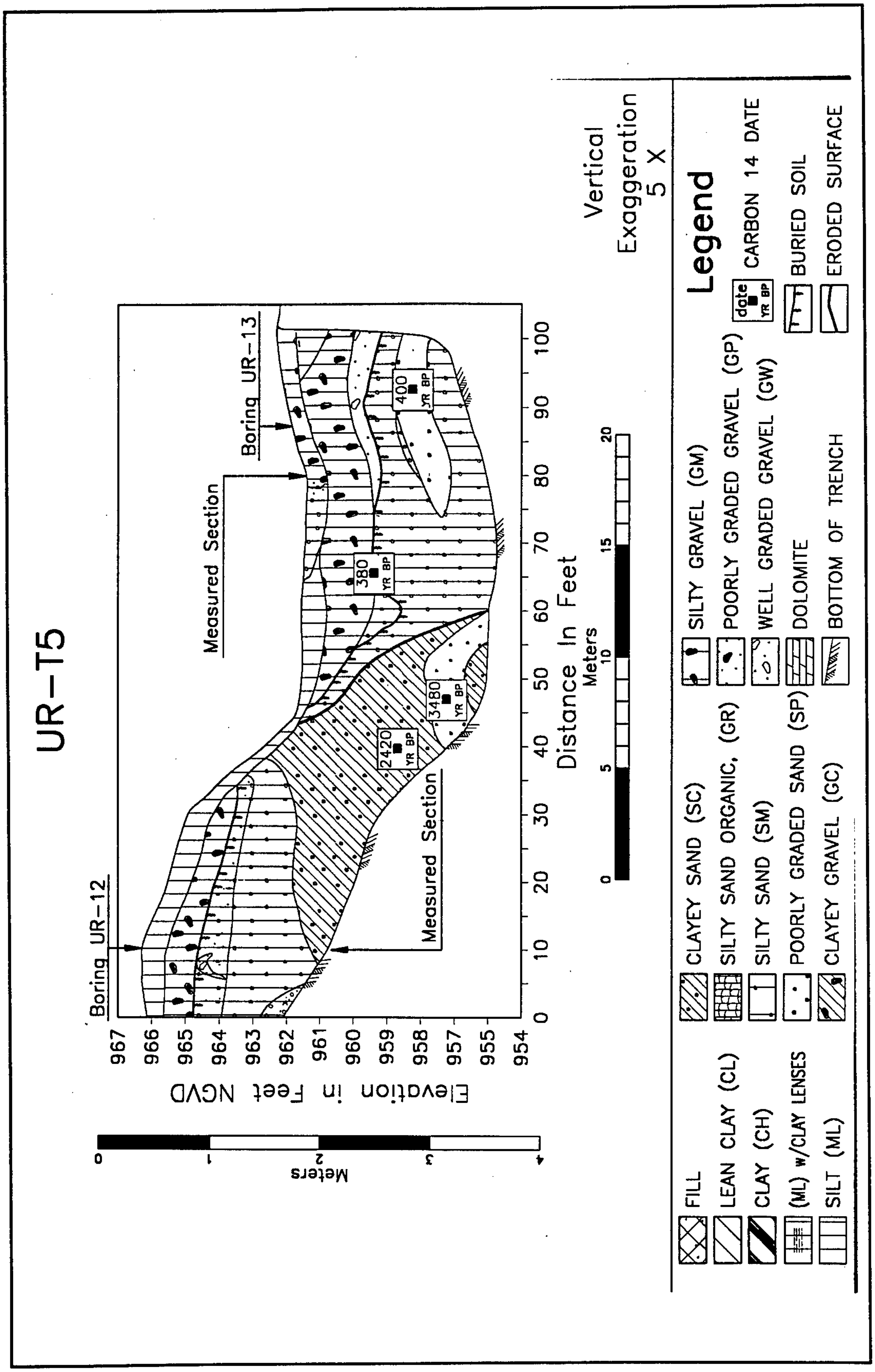


Figure 46. Trench UR-T5

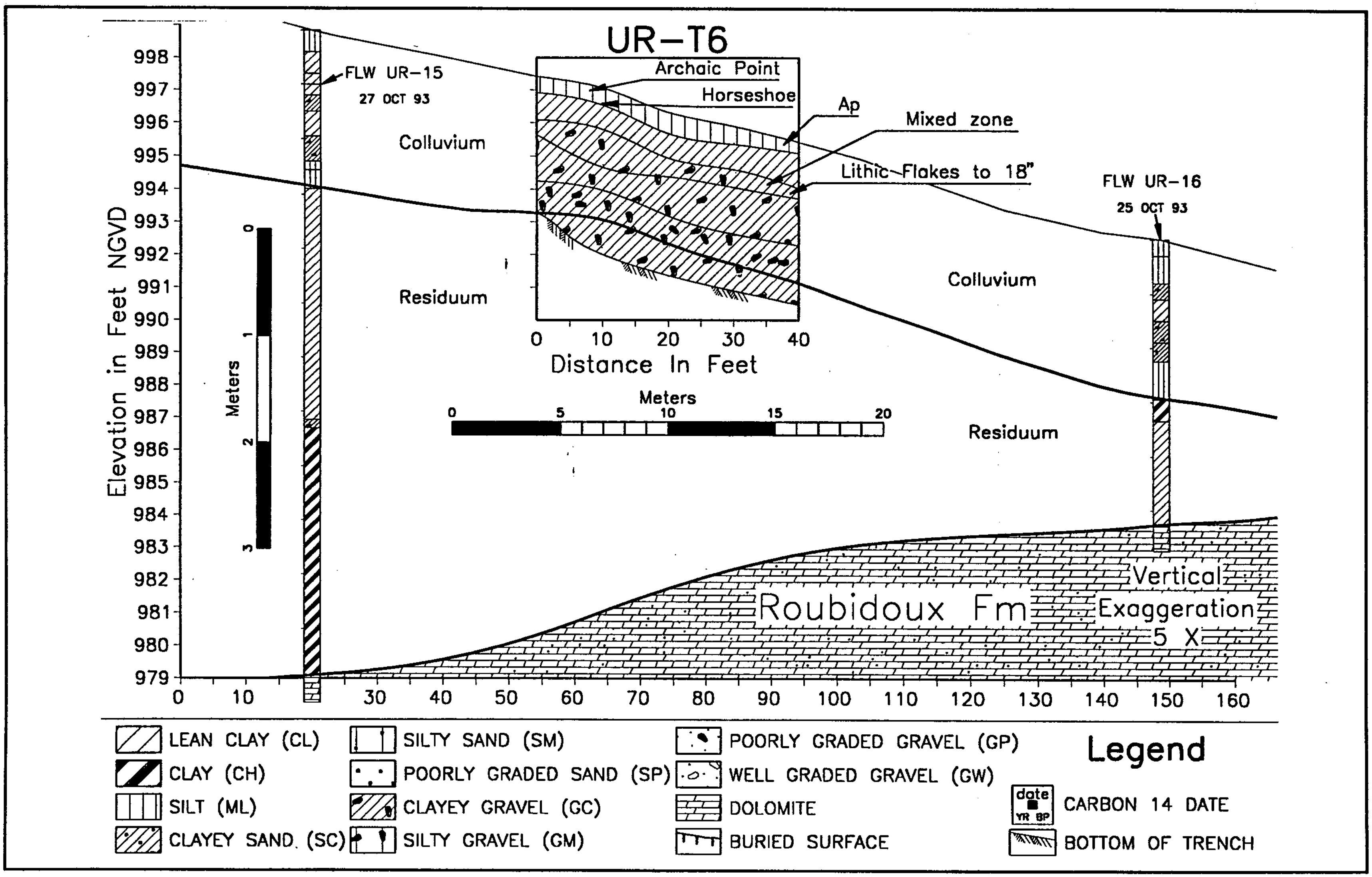


Figure 47. Trench UR-T6

Boring UR-4 and trench UR-T2 explored the eroded surface (Figure 43). The interpretation is that the surface designated as T7 was eroded and filled with hillslope colluvium and clayey alluvium during the T6 episode. The subsoil and surface form indicate that a period of truncation occurred after the T7 surface was deposited. The truncated area was later filled either by fines entering the lower area during floods or deposition of upland fines.

Trench UR-T3 (Figure 44) examined the break in slope and the lithologic discontinuity between borings UR-7 and 8 (Figure 41). About midway in the trench younger sediments are lapped on top of the older sandy and gravelly clays. Closer examination revealed two stacked buried soil horizons near boring UR-8. Silt blankets the surface, and may be a feature associated with vertical accretion during T5 time. The underlying materials near the base of the escarpment indicates that an overlapping depositional period has occurred, where T3 material was deposited upon the eroded or scoured surface of the T7 paleosol. Archaeologically, the upper foot (30 cm) of trench UR-T3 contained a lithic scatter and a diagnostic point of Late Archaic.

Trench UR-T4 also revealed overlapping contacts (Figure 45). Examination at trench UR-T4 station 90 showed the T3 Dundas formation is covered with a wedge of less pedological developed T2 Ramsey on top. Trench UR-T5 explored the geomorphic scarp between borings UR-12 and UR-13 (Figure 46). This particular trench reveals many lithological, pedological, and age differences. The sequence is interpreted as follows, the 3,480 years B.P. T4 Quesenberry material exposed between stations 40 and 60 ft was covered with 2,420 age T3 Dundas which was cut and filled at stations 50 though 95 ft with prehistoric 400 years B.P. sediments. The soil profile indicates buried soil horizons. The course-grained sediment above the buried soils are interpreted as historic flood deposits. Dundas T3 material dominates this particular trench (Figure 32). Comparison of UR-T4 (Figure 45) and UR-T5 (Figure 46) reveals the following onlap contact between that on the edge of the T3 surface a natural levee of T2 material. The gravelly sands at 30 to 40 cm depth from 90 to 130 ft in trench UR-T4 appear to be the distal edge of coarse grained levee deposits of T2 age deposited on the T3 surface and exposed from 0 to 35 ft in trench UR-T5. The T2 surface is represented here by variable deposits from floods of diverse energy levels. Using the mapping alloformation designations trench UR-T5 depicts T4 Quesenberry material covered with T3 Dundas which is in turn covered with T2 Ramsey material. All of the older sediments (T2, T3, and T4) are draped and covered with historic T1 sediments.

Trench UR-T6 was dug between borings UR-15 and -16 (Figure 47). The purpose was to further test the high terrace, later designated as T7co Laughlin. Exploration revealed colluvium overlying residuum with a strongly developed profile. This area represents a colluvial footslope with an archaeological site containing numerous artifacts from the Archaic through the historic.

Soil-geomorphic analyses of the Upper Roubidoux reach of the fort revealed soil-geomorphic units from the oldest T7co to the youngest

T1 historic sediments. The transect is typical of gaining stream reaches of Ozark fluvial system. The gravelly substratum is thinner than in the losing Lower Roubidoux reach. More terraces are preserved in the upper gaining Roubidoux reach than in the lower losing reach.

8 Soil Geomorphology and Cultural Resource Significance

Introduction

Objectives

The last and most important goal of the study was to establish the relationship between geomorphic features and the potential of having significant cultural resources associated with them. The objectives of this chapter are as follows: classify the alloformations according to their archaeological potential; provide guidance for locating sites that are of specific ages or contain specific cultural components; and identify areas that have high potential for site destruction or preservation by natural geomorphic processes.

Alloformations and archaeological significance

Each alloformation is described below in terms of the significance of the alloformation to the archaeological survey and cultural resource management work on Fort Leonard Wood. The age data for formation TO through T7 are presented in Table 5. Table 6 reviews the age and regional correlations. Table 7 estimates archaeological potential for surface and buried sites in general. Table 8 relates archaeological periods to the age range of the alloformations.

TO-Cooksville formation

The Cooksville formation consists of the channel and associated point bars of the Big Piney River and Roubidoux Creek. Elevation above the present steam surface is 0 to 0.6 m. Units range from 1/4 acre to approximately 10 acres in size. This formation ranges in age from 0 to approximately 100 years before present. Stream processes cause the bars to migrate downstream. The recent nature of its deposition results in no signs of pedogenesis.

Table 5 Radiocarbon Dates as Related to Alloformations This Study					
T1	T2	T3	T4	T5	T6
130	215[1]	2,100	3,480	4,390	
	340	2,020	3,900	4,630	
	360	2,230			
	370	2,380			
	380	2,420			
	400	2,980			
	630				
	1,370				
Dates From Brackenridge (1981)					
T0b	T0a	T1b4	T1b3	T1b2 and 1	T1a and T2
190	430	1,680[1]	3,610	5,200	13,550
260	620	2,360	3,985	6,300	13,700
330[1]	680		4,585[1]	7,290	16,450
	820			7,490	16,490
	840			8,030	16,540
				8,100	16,580
				10,200	...
				10,500	48,900

[1] Outside of norm.

This formation is represented by a miscellaneous unit: riverwash in the Pulaski County Soil Survey (Wolf 1989). Archaeologically, this unit has very low to no significance. Located here would be materials that had been removed by erosion from an older surface and redeposited. Occupation would have been very unlikely. Camping sites or fishing sites of short duration of historic age are possible.

Tl-Happy Hollow formation

The Happy Hollow formation consists of sand, gravel and some cobbles. This unit parallels the present stream. Elevation above the present stream surface is around 1.8 m. Size of the formation ranges from 1/4 acre to 7 acres. Materials in this formation range in age from 0 to 300 years before present. Signs of pedogenesis are weak in this formation. Most areas have

Table 6
Formations and Ages, Relationship to Brackenridge (1981)

Formation	Age (year B.P.)	Relationship to Brackenridge's
T0 Cooksville	0-100	No related unit. Present day gravel and sand bars. Separated with stream. Bars in process of migrating downstream.
T1 Happy Hollow	0-300	Related to Pippens formation. T0b unit. Carbon dates 190 to 330 years B.P. Alluvial deposition on surface consisting of sand, gravel, and cobbles.
T2 Ramsey	300-1,400	Related to Pippens formation. T0a. Carbon dates 430 to 840 years B.P. Alluvial deposition on surface consisting of sand and fine gravel.
T3 Dundas	2,000-3,000	Related to Rodgers formation. T1b4. Carbon dates 1,680 to 2,360 years B.P. Alluvial deposition on surface consisting of silts and very fine sands.
T4 Quesenberry	3,400-4,000	Related to Rodgers formation. T1b3. Carbon dates 3,610 to 4,585 years B.P. Some formations with alluvial deposition on surface.
T5 Miller	4,300-10,000	Related to Rogers formation. T1b1 and T1b2. Carbon dates 5,200 to 10,200 years B.P. No alluvial deposition on surface. Holocene deposits.
T6 Ousley Spring	10,000-55,000	Related to the Trolinger Spring and possibly Koch and Boney Springs formations. T-1a and T-2. Carbon dates 13,550 to >48,900 years B.P. Pleistocene deposits.
T7 Stone Mill	10,000-130,000	Related to Breshears formation. T3. No radiocarbon dates.
T7co Laughlin Unit	10,000->55,000	No related unit. Unit occurs in close proximity to alluvial soils. A variable unit consisting of colluvium, reworked loess, residuum, or a combination thereof.
AF McCann	0-55,000	No related unit. Alluvial fans.
TR1 Baldridge	0-2,000	No related unit. Small tributaries.
TR2 Hanna	2,000-8,000	No related unit. Medium to large tributaries.

been stable long enough to allow the development of a surface horizon. The majority of the historic surface has been buried by more recent deposition. This formation has a very low archaeological significance. As in the Cooksville formation artifacts will be limited and consist of items redeposited from the destruction of other formations. Occupation, except for utilitarian purposes and short duration, would have been unlikely. Camping sites or fishing sites of historic age are possible.

Table 7
Archeological Site Potential of Alloformation at Fort Leonard Wood

Formation	Depth - Relative Site Potential: Surface	Depth - Relative Site Potential: Buried/Below Surface	Present Drainage and Flooding (Notes)
T0 Cooksville	(0.5m) vlow (scatter only)	(2m) vlow	Somewhat excessively to excessively drained, frequently flooded
T1 Happy Hollow	(0.5m) vlow (dom. scatter)	(2m) low	Well to excessively drained, frequently flooded
T2 Ramsey	(0.5) low/mod	(2m) low/mod	Well to somewhat excessively drained, frequently flooded
T3 Dundas	(0.5)m mod	(2m) high	Well to moderately well drained, frequently flooded. Dead Deer site occurs in Dundas.
T4 Quesenberry	(0.5m/up bdy arg) high	(1.5m) low/mod	Well drained, occasionally to rarely flooded, often long narrow areas with escarpment.
T5 Miller	(0.5m/up bdy arg) high	(1m) low/mod	Well drained, occasionally to rarely flooded.
T5w Miller (Wet)	(0.5m/up bdy arg) low/mod	(1m) low/mod	Poorly drained, occasionally to rarely flooded.
T6 Ousley Spring	(0.5m/up bdy arg) low/mod	(1m) low	Somewhat to very poorly drained.
T7 Stone Mill	(0.5m/up bdy arg) high	(1m) low/mod	Well to moderately well drained, prom. escarp.-strata terrace.
T7co Laughlin Unit	(0.5m/up bdy arg) mod	(1m) vlow/low	Well to moderately well drained.
AF McCann	(0.5m/up bdy arg) low/high	(1m) low/mod	Well drained, rarely to frequently flooded.
TR1 Baldridge	(0.5m) low	(2m) low	Well to somewhat excessively drained, frequently flooded.
TR2 Hanna	(0.5m/up bdy arg) mod/high	(1m) low/mod	Well drained, frequently to occasionally flooded.
Additional Units/Subscripts:			
B	Borrow areas		Potential sites destroyed.
C	Construction areas		Potential sites destroyed or buried.
CO	Colluvial wedge areas, var. age upland to valley transition		Low to moderate potential buried sites.
E	Erosional surface - escarpment related to adjoining upslope delineation, with or without bedrock		Potential for exposed sites and related scatters.
s	Area dominated by slough		Potential for buried sites and scatters.

Table 8
Relationship Between North America Archaeological Periods and Age Ranges of Alloformation at Fort Leonard Wood

Formation	Age (year B.P.)	Archaeological Periods	
		Upper 50 cm	Buried
T0 Cooksville	0-100	Historic	Historic
T1 Happy Hollow	0-300	Historic	Historic
T2 Ramsey	200-1,400	Late Mississippian	Late Woodland
T3 Dundas	2,000-3,000	Middle Woodland	Early Woodland
T4 Quesenberry	3,400-4,000	Early Woodland	Late Archaic
T5 Miller	4,300-8,000	Late Archaic	Early Archaic
T6 Ousley Spring	10,000-55,000	Dalton	Paleo-Indian
T7 Stone Mill	10,000-130,000	Dalton	Paleo-Indian
T7co Laughlin Unit	10,000->55,000	Dalton	Paleo-Indian
AF McCann	0-55,000	Dalton	Paleo-Indian
TR1 Baldridge	0-2,000	Late Mississippian	Middle Woodland
TR2 Hanna	2,000-8,000	Middle Woodland	Early Archaic

T2-Ramsey formation

Sand is the dominant component of the Ramsey formation. This formation is wide, elongated and nearly level running parallel to the present stream. Elevation above the present stream surface is around 2.7 m. Size of the formation ranges from 1 to 60 acres. Deposition of the Ramsey formation spanned the period from 300 to 1,370 years B.P. based on age dates (Appendix C) and possibly reaches up to 1,600 years before present (correlated to Brackenridge 1981). Cumulic surfaces have formed on this unit and the dark colors extend to a depth of 40 in. (1 m) or more. This formation has low archaeological significance. Permanent occupation would not have been very likely due to the frequency of flooding. Non-permanent sites of short duration are more likely, such as hunting and fishing camps or trading expeditions. Materials from the Late Mississippian are possible in the upper 20 cm and buried materials could date to the Early Mississippian.

T3-Dundas formation

Silt and sand are the major components of the Dundas formation with silt dominating. Small areas with less than 35 percent gravel occur. It is nearly level and parallels the present stream to an extent. Elevation above the present stream surface is around 3.4 m. Size of the formation ranges from 1 to 70 acres. The age of the Dundas formation encompasses the years from 1,600 to 3,000 before present. Dark surfaces occur on this formation and extend to a depth of 6 to 18 in. This formation has a medium to low archaeological significance. Permanent occupation would still not have been very likely due to the frequency of flooding during the Woodland period and occasional to frequent flooding into the present. Non-permanent sites of short duration are more likely, such as hunting and gathering camps or trading expeditions. Base camps outside the Ozarks are a possible source of these expeditions starting in the Middle Woodland period. Materials from the Early Mississippian period to the present are possible in the upper 20 cm and buried materials could date to the Early Woodland.

T4-Quesenberry formation

The Quesenberry formation marks the first major geomorphic separation. The previously discussed formations could be considered as making up the present day floodplains. The Quesenberry formation is the initiation of what could be considered the terrace system. Formations range from rarely to non-flooded. Deposition of material consists of very fine sand particles on old natural levees. The unit is nearly level, wide to narrow, and elongated to rectangular. The formation parallels the boundaries of old meanders. Elevation above the present stream surface is around 4.2 m. Size of the formation ranges from 1 to 20 acres. The age of the Quesenberry formation extends from 3,400 to 4,000 years before the present. Dark surfaces occur on this formation and extend to a depth of 7 to 8 in. This formation has a medium archaeological significance. Seasonal occupation, hunting and gathering camps or trading expeditions become more likely beginning on the Quesenberry formation. It also is expected that occupation on higher surfaces overlapped onto this formation. Materials from the Early Woodland period to the present are possible in the upper 20 cm and buried materials could date to the Late Archaic.

T5-Miller formation

The Miller formation is dominated by silt. Past clearing of this formation is evident and it is now in the process of regeneration. The unit is nearly level, wide and rectangular. The formation parallels the boundaries of old meanders and or shows no relation to the present day stream pattern. Elevation above the present stream surface is around 5.5 m. Size of the formation ranges from 1/4 to 180 acres. The age of the Miller formation is in the vicinity of 4,300 to 10,000 years before present. The Miller formation has a high archaeological significance. Permanent occupation or base camps on the

larger units would be expected. Smaller hunting and gathering camps or trading expeditions would also be possible. Materials from the Late Archaic period to the present are possible in the upper 20 cm and buried materials could date to the Early Archaic.

A few sloughs (T5s) were separated from the formation. These no longer carry flood water but paleodrainage can be inferred from their location.

T6-Ousley Spring formation

Clay is the dominate particle size of the Ousley Spring formation. As a result drainage problems exist. The formation is gently sloping, wide and rectangular. The formation shows no relation to the present day stream pattern and the majority of this formation is found in old cut-off meanders. Elevation above the present stream surface ranges from 6.7 to 10.5 m. Size of the formation ranges from 2 to 120 acres. The Ousley Spring formation's age is estimated from 10,000 to 55,000 years before present based on correlations with Brackenridge's (1981) geochronology. Light surfaces dominate this formation. This formation has a medium to low archaeological significance. Permanent occupation or base camps would not be expected due to the somewhat poorly drained conditions. Seasonal occupation would have been possible in drier years. Given the possibility of these units being a source of water, archaeological sites may overlap from better drained formations nearby. Materials from the Dalton period to the present are possible in the upper 20 cm and buried materials could date to the Paleo-Indian period.

T7-Stone Mill formation

The Stone Mill formation represents the second major geomorphic separation. It occurs as remnants of a much older surface and would be considered a strath terrace. Height above the younger formations ranges 10 to 20 ft (3 to 6 m). An erosional escarpment with or without bedrock occurs in some locals. Elevation above the present stream surface ranges from 8.5 to 18 m. Size of the formation ranges from 2 to 40 acres. The age of the Stone Mill formation ranges from 10,000 for the loess deposition to 130,000 plus years before present according to Brackenridge (1981). The surface of the formation is light.

This formation has a high archaeological significance. Permanent occupation or base camps would be expected. Portions of sites could have been destroyed from truncation of the stream or upland drainages. Historic sites are common on this formation and they overlap into the T7co unit. Materials from the Dalton period to the present are possible in the upper 20 cm and buried materials especially near the surface of the paleosol could date to the Paleo-Indian period. This is only a presumption and from past archaeological studies in Missouri, materials from the Paleo-Indian period in the area of the study have been limited.

T7co-Laughlin unit

The Laughlin unit represents the upland footslopes. It was separated in this study of alluvial soils because of its close proximity to the stream channel, its geomorphology and the presence of overlapping archaeological sites. It is moderately to strongly sloping, narrow and rectangular. The formation shows no relation to the present day stream pattern. Elevation above the present stream surface ranges from 12.2 to 20 m. Size of the formation ranges from 1 to 20 acres. The age of the Laughlin unit is similar to that of the Stone Mill formation. It ranges from 10,000 to 130,000 plus years before present. This formation has a medium archaeological significance. Historic sites or the overlapping of historic sites from the Stone Mill formation are common. Materials from the Dalton period to the present are possible in the upper 20 cm and buried materials could date to the Paleo-Indian period.

AF-McCann formation

The McCann formation consists of alluvial fans. The formation is moderately sloping, fan-shaped and shows no relation to the present day stream pattern. The formation is related to the materials and size of the tributary from which it arises. Elevation above the present stream surface ranges from 3.4 to 9 m. Size of the formation ranges from 1/8 to 10 acres. The McCann formation includes the ages from 0 to 55,000 years before present. This formation has a medium to low archaeological significance. Due to the small size of the units and the gravelly nature of the surface it is unlikely that either non-permanent or permanent prehistoric camps were located here. Several historic sites are located on this formations and because of this formations close proximity to better suited formations, overlapping of sites may occur. Materials from the Dalton period to the present could be found in the upper 20 cm and buried materials as old as the Paleo-Indian period could be discovered.

TR1-Baldridge formation

The Baldridge formation is found in the large to small tributaries of Roubidoux Creek. On the basis of age and pedimorphic form this formation is probably related to the Ramsey formation. The formation is moderately sloping, linear and parallels the present day channel of the tributaries. The formation is related to the materials and size of the tributary from which it arises. Elevation above the present stream surface is 2.7 m. Size of the formation ranges from 5 to several hundred acres. The Baldridge formation ranges in age from 0 to 1,600 years before the present. The surface of the formation is cumulic with the dark materials extending to a depth of 40 in. (1 m) or more. This formation has a low archaeological significance. Due to the size of the units and the flooding frequency it is unlikely that either non-permanent or permanent camps were located here. Because of this formations close proximity to better suited formations, materials may be found here due to erosion and redeposition or overlapping of sites. Materials from the Late

Mississippian period to the present could be found in the upper 20 cm and buried materials as old as the Middle Woodland could be discovered.

TR2-Hanna formation

The Hanna formation is found in the small to mid-size tributaries in the northern section of Roubidoux Creek. This formation is deposited on or truncates the formations older than the T4 Quesenberry. The formation is moderately sloping, linear and parallels the present day channel of the tributaries. The formation is related to the materials and size of the tributary from which it arises. Elevation above the present stream surface is 7.6 m. Size of the formation ranges from 2 to 200 hundred acres. The Hanna formation ranges in age from 4,000 to 8,000 years before the present. This formation has a medium archaeological significance. Due to the size of the units and the gravel content it is unlikely that either non-permanent or permanent prehistoric camps were located here. Historic sites are known to occur on this formation and because of this formations close proximity to better suited formations, overlapping of sites may occur. Materials from the Middle Woodland period to the present could be found in the upper 20 cm and buried materials as old as the Early Archaic could be discovered.

Miscellaneous Units

B-Borrow areas

This unit constitute sites that have had the original surface and subsoil removed for construction purposes. These sites are generally located in the older formations and have no vegetative cover. The potential for preservation of significant archaeological materials or sites in this unit are very low because of recent removal of material from these areas.

C-Construction areas

This unit includes tracts of land utilized for construction of military structures, parking areas and training areas. It also includes areas where training for construction has taken place. The potential for preservation of significant archaeological materials and sites in the unit are very low because of the recent disturbance and mixing of the soil.

CO-Colluvial wedge area

These units consist of zones of gravelly colluvial at the base of slopes. They have a low archaeological significance. Materials may occur here due to the close proximity of more suitable formations.

E-Escarpment W/WO bedrock

A steep relatively short erosional escarpment is the main component of this unit. Some areas have bedrock exposed along the lower edge. The escarpments are a result of the lateral scouring of the Big Piney River during the abandonment of the Stone Mill formation. The nature of this unit points to a very low archaeological significance.

Prediction of Site Occurrence

The approach that was used to define the relationships between known archaeological sites and geomorphic features involved identifying the known archaeological sites, evaluating the geomorphic site data from the recorded sites, and identifying characteristics that relate the archaeological sites to the geomorphic features. These characteristics were then evaluated to predict the locations of undiscovered sites according to their geomorphic context. It is important to emphasize that the primary purpose of this analysis is to show general relationships between the various landforms that comprise the study area and the potential for archaeological sites contained within this area. This **study is not meant to be an archaeological analysis.**

The distribution of the known archaeological sites as identified indicates that sites are not random, but are clearly associated with specific landforms in the project area. Geomorphic relationships for the known sites can be used to locate and interpret as yet undiscovered sites, and guide the subsequent archaeological analysis of the individual sites and the entire study area. Geomorphic relationships identified by this study should help to improve the efficiency of future cultural resource investigations in the project area and maximize findings. Geomorphic data indicates that some abandoned floodplains comprising the stepped valley surface may possibly have formed during the early Holocene or late Pleistocene. Archaeological site data may provide additional evidence to the age of the various floodplain components.

Previous studies have proposed models (Reeder 1988, Saucier 1987 and Johnson 1981) to address the visibility and the preservation of the archeological sites. These models agree on the fact that the archaeological record is a partial reflection of the prehistoric settlement patterns due to post depositional and erosional processes, and the inability of some survey methods to detect buried sites. However, the models differ on the reach of streams studied and depth of site burial.

For example, Johnson's (1981) work on the lower Pomme de Terre is similar to the lower reaches of the Big Piney River and Roubidoux Creek on Fort Leonard Wood. Johnson proposed that floodplain components younger than 2,000 years BP, would be in the upper 50 cm. In this study, the T2 Ramsey corresponds to Johnson's < 2,000 years BP, alluvium. Table 7 agrees that there is low to moderate site potential to 0.5 m but also extends the potential to 2 m. The next soil-geomorphic unit, the T3 Dundas with an

age range of 2,000 to 3,000 years BP has moderate potential in the upper 50 cm but has high potential for buried sites to a depth of 2 m. On the other hand, Benn and Purrington (1985) model is applicable to secondary streams such as the upper reaches of the Roubidoux Creek. Their model proposes that smaller streams have scoured the landscape removing earlier sites. The present study concurs, specifically to the tributary units where TR1 has scoured and removed portions of TR2. Consulting Table 7 reveals that younger TR1 has low potential while TR2 has moderate to high potential in the upper 50 cm. Benn and Purrington (1985) further suggest that sites not subjected to scour, especially the sites on the second and third terraces are expected to be located at depths less than 1 m. The corresponding mapping units to their second and third terraces are the T4 Quesenberry and T5 Miller formations. Table 7 shows high potential in the upper 50 cm with low to moderate potential to 1.5 and 1 m respectively.

The previous models are a good starting point but are only general in nature. Paleoenvironmental conditions have been dynamic with geomorphic processes operating on different landscape features at varying rates. Thus, the conclusion of this study is site preservation is more site specific and recommends the use of the detailed maps and tables for prediction of site potential.

Site Preservation and Destruction

Introduction

In the Fort Leonard Wood project area a number of processes are or have been at work either preserving or destroying the evidence of prehistoric groups. Most evident of these processes are the result of historic human activity, such as cultivation of the soil, timbering, construction of roads, buildings, and dams. However, natural processes have also played a key role in the preservation or destruction of the archeological record. Some geomorphic processes, such as colluvial deposition or fluvial sedimentation may serve to preserve the record through burial. Erosional processes may destroy sites by redistribution or destruction of the surfaces where sites occur. In the following paragraphs, the archeological significance of several processes are discussed, including fluvial sedimentation, chemical weathering, and fluvial scouring.

Fluvial sedimentation and site preservation

An understanding of fluvial sedimentation rates is important in evaluating artifact decay and preservation characteristics. Knowledge about sedimentation rates is also important in understanding the stratigraphic or chronological significance of the archaeological record. Rapid sedimentation will promote the preservation and superposition of artifacts and features that result from serial occupation of sites. In contrast, slow sedimentation rates will result in

the accumulation of archaeological debris as mixed assemblages and increase the potential for artifact decay by chemical and physical causes.

Discussion

Preservation and destruction qualities of landforms are site dependent and are based on a number of interdependent variables. These variables include soil pH, soil moisture, wet aerobic or anaerobic environments, types of microorganisms and microorganisms present, sediment movement, and soil loading. The relationships between these variables are very complex. They can vary slightly and result in different decay properties for the different artifact types. The majority of artifacts identified in the archaeological site descriptions are lithics. These artifacts are least affected by chemical and physical weathering.

Chemical weathering promotes the decay of bone, shell, charcoal, and pottery. Stone artifacts are not affected. With increasing sedimentation rates and burial, artifact preservation is greatly enhanced as burial reduces the rate at which chemical weathering occurs. Archaeological sites are most threatened on the summits and on the side slopes where sedimentation rates are very low or where erosion is the dominant process.

Archaeological sites are more likely to be protected adjacent to or near the main channel where maximum sedimentation and burial occurs. Sites that are in close proximity to the main channel and not in the direct path of lateral migration by the river are buried by vertical accretion. Other factors to be considered in a discussion of artifact preservation and decay for geomorphic systems include flooding effects, groundwater movements, and fluvial scouring. All surfaces when adjacent to the stream are subject to scouring due to migration of stream meanders. Terraces are especially affected by groundwater movements as they are composed primarily of unconsolidated sediments and are hydraulically connected to the main channel.

There are no strict rules governing archaeological site preservation or destruction as a function of the respective landforms and associated geomorphic processes. Various trends or generalizations have been identified above which can be used as guidelines in evaluating the archaeological significance of the different landforms. Specific areas or individual archaeological sites should be examined and evaluated on the merits of each site.

9 Summary and Conclusions

The purpose of this investigation was to analyze and provide soil-geomorphic evidence to support the cultural resource management at the Fort Leonard Wood Military Reservation. Most archaeological survey and testing projects do not account for complex geomorphic processes that may have affected the visibility and integrity of archaeological sites. Therefore, the primary objective of this study is to provide soil and landform data that will aid in the detection and preservation of archaeological sites. Moreover, this study addresses three major problems facing the detection of archaeological sites on military installations. First, buried, stable, or altered landscapes often contain significant sites that may be impacted by military activities. Second, geomorphological processes must be addressed prior to any archaeological survey or site testing in alluvial settings, and third, site detection methods based on geomorphic data can be developed that address these problems and in the long-term are cost-effective. The study will be used to select areas of high potential for archaeological site preservation. Significant emphasis is placed on identifying locations of rapid alluvial deposition which may conceal deeply buried archaeological sites. The approach was to develop a detailed alluvial history at selected representatives sites using soil cores, trenching, pedological analysis, and radiometric dating. A detailed history was extrapolated by mapping soil-geomorphic units based on geomorphic position, stratigraphic succession, sedimentology, and pedogenic development at a 1:12,000 scale for the Fort Leonard Wood Military Reservation.

The valley bottoms of the Big Piney River and Roubidoux Creek were differentiated into twelve soil-geomorphic units. Table 7 relates the formations to their archaeological potential. Using the table with the enclosed geomorphic plates for each section the area can be evaluated for archaeological potential. For example, section 7 T35N R11W in the Lower Roubidoux cultural resources zone is dominated with T5, the Miller formation. In examining Table 7, T5 has a high potential in the upper 0.5 meters and a low to moderate potential to 2 meters at depth. Radiometric dating of the T5 Miller formation indicates ages between 4,000 to 5,000 years before present (Table 5). Therefore, from a geo-archaeologically perspective, the T5 Miller formation has been a stable landform since the Archaic Period (Table 8). Another common soil-geomorphic unit occurring in section 7 (see plate) is the T2 Ramsey formation. Consulting Table 7 the T2 Ramsey formation has a low to moderate potential at the surface and to 2 meters at depth. Radiometric dates from the T2 Ramsey formation indicates ages from 200 to

1,400 years before present (Table 5). In terms of the archaeological record the T2 Ramsey formation has a potential to contain Late Woodland to European contact period artifacts.

Other peak areas of archaeological site potential (Table 7) should be evaluated based upon the section (see plates) and their corresponding relationship with archeological period artifacts (Table 8). For example, the T4 Quesenberry formation has a high potential in the upper 0.5 meters and a low to moderate potential to 1.5 meters at depth. Radiometric dating of the T4 Quesenberry formation indicates ages between 3,400 to 4,000 years before present (Table 5). The archaeological record of the T4 Quesenberry formation has a potential to contain Early Woodland to Late Archaic contact period artifacts. Another significant soil-geomorphic unit would be the T7 Stone Mill formation. The T7 Stone Mill formation has a high potential in the upper 0.5 meters and a low to moderate potential to 1 meter at depth. Radiometric dates were not analyzed for this formation. The archaeological record indicates that the T7 Stone Mill formation has a potential to contain Dalton to Paleo-Indian contact period artifacts.

The geomorphic study carefully analyzed the landforms occurring in the valleys of Fort Leonard Wood Military Reservation. The cultural resource manager now has the valley bottoms mapped at a scale of 1:12,000 with corresponding tables to define the potential for preservation of the archaeological record at the surface and/or buried to 2 meters. The geomorphic units are placed in a geochronology to allow temporal archaeological interpretations of the last 14,000 years before present on the military reservation.

In summary, this study indicates that geomorphological processes have affected the archaeological record at Fort Leonard Wood. Archaeological site visibility, the destruction of sites dating to particular time periods, and varying degrees of stratigraphic separation at multi-component sites suggest that impacts to sites are not uniform but are determined by a sites's geomorphology, location, and age.

References

Ahler, S. R., and McDowell, J. M. (1993). "Phase I cultural resource inventory of selected tracts at Fort Leonard Wood, Pulaski county, Missouri," Report prepared for U.S. Army Construction Engineering Research Laboratory, Champaign, IL, Public Service Archaeology Program Research Report, No. 9, University of Illinois, Department of Archaeology Urbana, IL.

Autin, J. A. (1992). Use of alloformations for definition of Holocene meander belts in the middle Amite River, Southeastern Louisiana. *Geological Society of America Bulletin* 104:233-241.

Benn, D. W., and Purrington, B. L. (1985). Sampling strategy and survey techniques. In A cultural resources survey and test excavations in Mark Twain National Forest, Missouri: 1982-1983, complied by B. L. Purrington, pp. 276-291. Report by the Center for Archaeological Research, Southwest Missouri State University for the USDA-Forest Survey.

Brackenridge, G. R. (1981). Late quaternary floodplain sedimentation along the Pomme de Terre River, southern Missouri. Quaternary Research, 15:62-76.

Bretz, J. H. (1965). Geomorphic history of the Ozarks of Missouri. Vol. XLI, Second Series. Missouri Geological Survey and Water Resources, Rolla, MO.

Buol, S. W., Hole, F. D., and McCracken, R. J. (1980). Soil genesis and classification, second edition. Iowa State University Press, Ames, IA. 360 pp.

Dan, J., and Yaalon, D. H. (1968). Pedomorphic forms and pedomorphic surfaces. International Congress of Soil Science Transactions. Vol. IV, 577-584.

Daniels, R. B., and Hammer, R. D. (1992). *Soil Geomorphology*. Somerset, NJ: John Wiley & Sons, Inc., NY, 254.

Gamble, E. E. (1993). Geomorphic Study in the Upper Gasconade River Basin, Laclede and Texas Counties, Missouri.

Guccione, M. J. (1991). "Interior highlands," *Quaternary Nonglacial Geology: Conterminous U.S.*, R. B. Morrison, ed., Decade of North American Geology, Vol. K-2, Boulder, CO: Geological Society of America, 531-546.

Haynes, C. V., Jr. (1976). Late quaternary geochronology of the lower Pomme de Terre valley. In *Prehistoric Man and his Environments: a case study in the Ozark Highland*, edited by W. R. Wood and R. B. McMillan, pp. 47-61. Academic Press, New York.

__________. (1985). Mastodon-bearing springs and late quaternary geochronology of the lower Pomme de Terre Valley, MO. Geological Society of America Special Paper 204.

Hershey, O. H. (1895). River valleys of the Ozark plateau. The American Geologist, 16:338-357.

Jenny, H. (1961). Derivation of state factor equations of soils and ecosystems. Soil Science Society American Proceedings 25: 385-388.

Miall, A. E. (1985). "Architecture-element-analysis: A new method of facies analysis applied to fluvial deposits." *Earth Science Review* 22, 261-308.

North American Commission on Stratigraphic Nomenclature. (1983). "North American Stratigraphic Code." *American Associate of Petroleum Geologists Bulletin* 67 (5), May, 841-875.

Reeder, R. E. (1988). *Prehistory of the Gasconde River Basin*, Phd Dissertation. University of Missouri, Columbia, MO, 356.

Ruhe, R. V. (1969). Quaternary Landscapes in Iowa. Ames: Iowa State University Press.

Saucier, R. (1987). Geomorphological studies, in Archaeological Investigations in the Ozark National Scenic Riverways, 1984-1986. Conducted for the National Park Service Midwest Archaeological Center, Lincoln, NE, by the Center for Archaeological Research, Southwest Missouri State University, Springfield, MO, Project No. CAR-675.

Schumm, S. A. (1977). The Fluvial System. New York: Wiley.

Simonson, R. W. (1959). Outline of a generalized theory of soil genesis. Soil Science Society American Proceedings 23: 152-156.

Soil Survey Staff. (1975). Procedures for collecting soil samples and methods of analysis for soil survey, Soil Survey Investigations Report No. 1, Revised. U.S. Department of Agriculture Soil Conservation Service, Washington, DC. 97 pp.

Soil Survey Staff. (1975). Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. U.S. Department of Agriculture Handbook No. 436, Washington, DC.

Soil Survey Staff. (1984). Procedures for collecting soil samples and methods of analysis for soil survey, Soil Survey Investigations Report No. 1, Revised. U.S. Department of Agriculture, Soil Conservation Service, Washington, DC. 97 pp.

Soil Survey Staff. (1993). Soil Survey Manual. U.S. Department of Agriculture Handbook No. 18, Revised. Washington, DC.

The North American Commission on Stratigraphic Nomenclature. (1983). North American Stratigraphic Code, The American Association of Petroleum Geologists Bulletin, Vol. 67, No. 5.

Thompson, T. L. (1991). Paleozoic Succession in Missouri, Part 2--Ordovician System: Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations No. 70.

Thompson, T. L., and Robertson, C. E. (1993). *Guide to the Geology Along Interstate Highway 44 (I-44) in Missouri*, Report of Investigation No. 71. Rolla, MO: Missouri Department of Natural Resources Division of Geology and Land Survey, 185.

Wolf, D. W. (1989). *Soil Survey of Pulaski, Missouri*. Washington, DC: United States Department of Agriculture, Soil Conservation Service, 120.

Yaalon, D. H. (1983). Climate, time and soil development. pp. 233-251.

Soil Survey Staff. (1975). Procedures for collecting soil samples and methods of analysis for soil survey, Soil Survey Investigations Report No. 1, Revised. U.S. Department of Agriculture Soil Conservation Service, Washington, DC. 97 pp.

Soil Survey Staff. (1975). Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. U.S. Department of Agriculture Handbook No. 436, Washington, DC.

Soil Survey Staff. (1984). Procedures for collecting soil samples and methods of analysis for soil survey, Soil Survey Investigations Report No. 1, Revised. U.S. Department of Agriculture, Soil Conservation Service, Washington, DC. 97 pp.

Soil Survey Staff. (1993). Soil Survey Manual. U.S. Department of Agriculture Handbook No. 18, Revised. Washington, DC.

The North American Commission on Stratigraphic Nomenclature. (1983). North American Stratigraphic Code, The American Association of Petroleum Geologists Bulletin, Vol. 67, No. 5.

Thompson, T. L. (1991). Paleozoic Succession in Missouri, Part 2--Ordovician System: Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investigations No. 70.

Thompson, T. L., and Robertson, C. E. (1993). *Guide to the Geology Along Interstate Highway 44 (I-44) in Missouri*, Report of Investigation No. 71. Rolla, MO: Missouri Department of Natural Resources Division of Geology and Land Survey, 185.

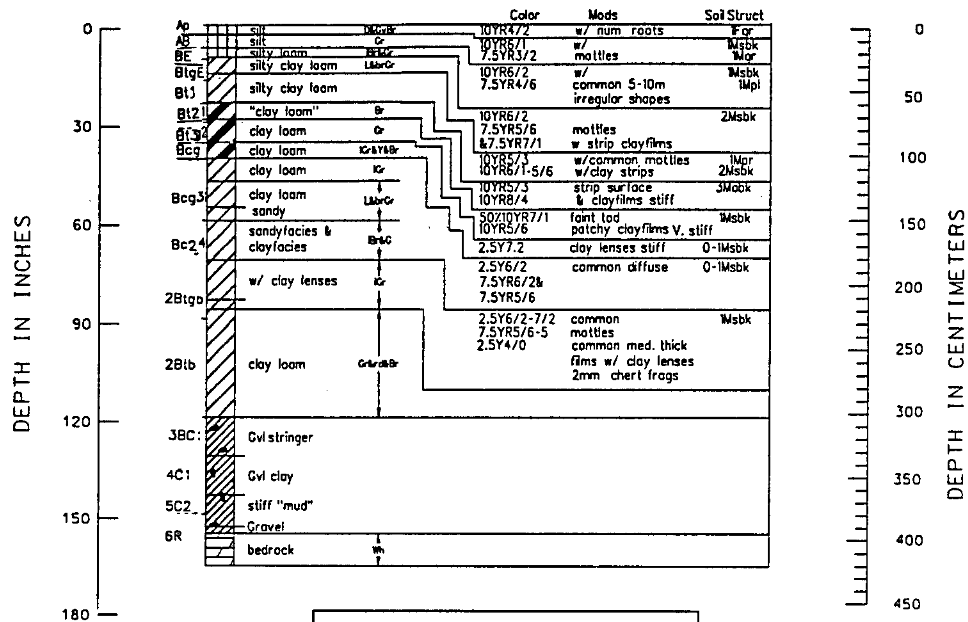
Wolf, D. W. (1989). *Soil Survey of Pulaski, Missouri*. Washington, DC: United States Department of Agriculture, Soil Conservation Service, 120.

Yaalon, D. H. (1983). Climate, time and soil development. pp. 233-251.

Appendix A
Soil Boring Logs

FLW HH-1

13 JUL 93

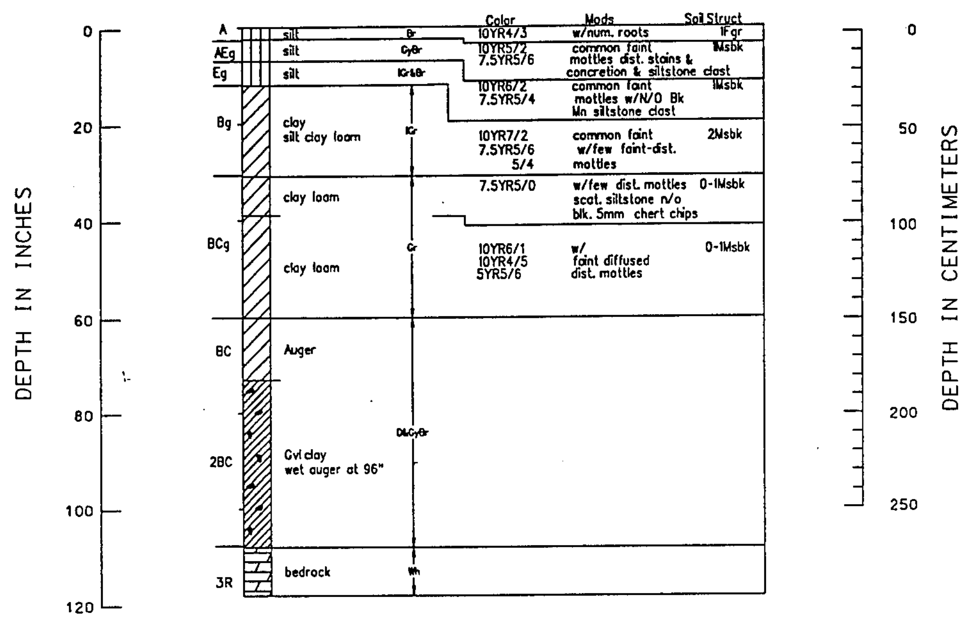


Happy Hollow 1

Fort Leonard Wood

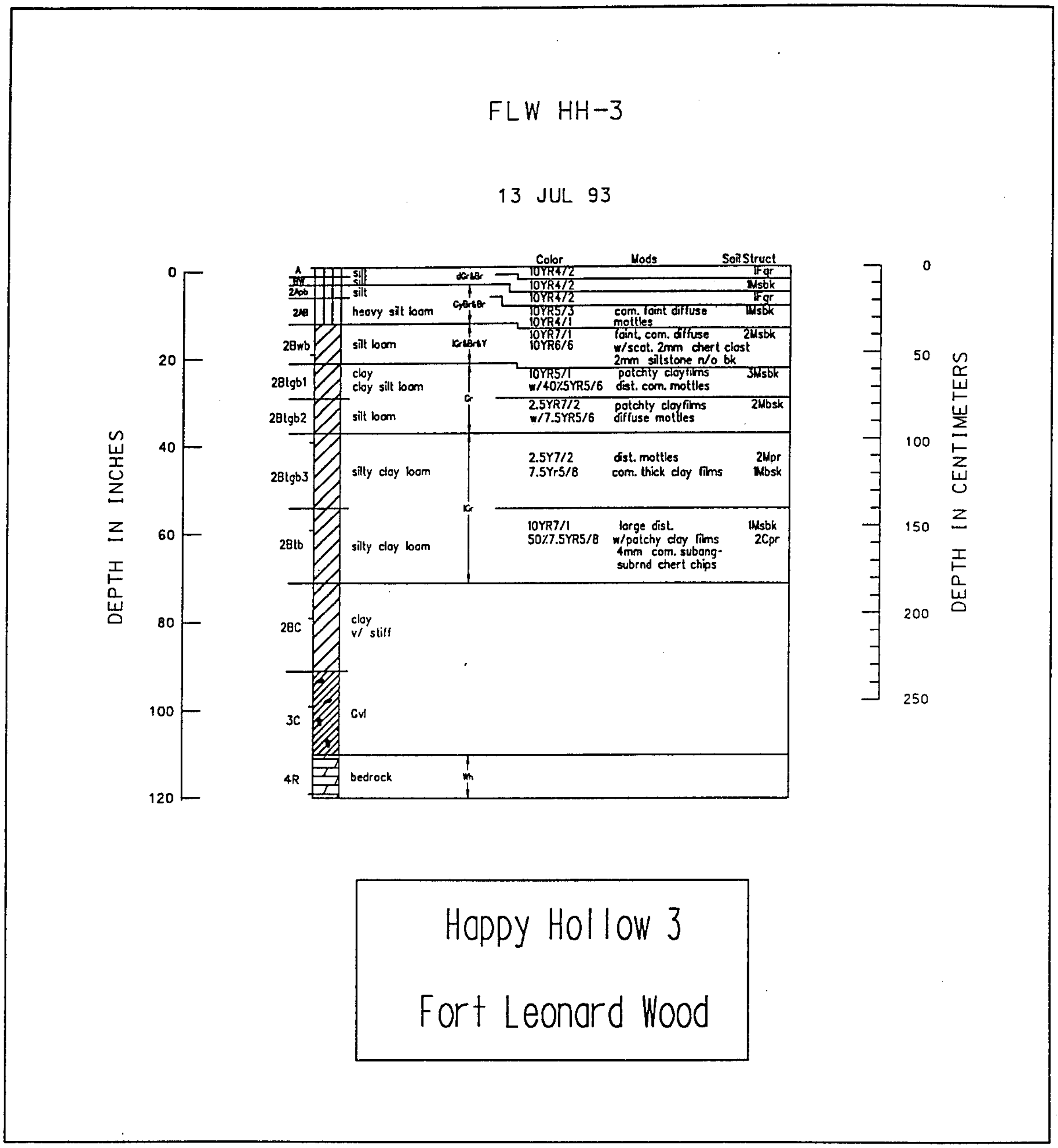
FLW HH-2

13 JUL 93



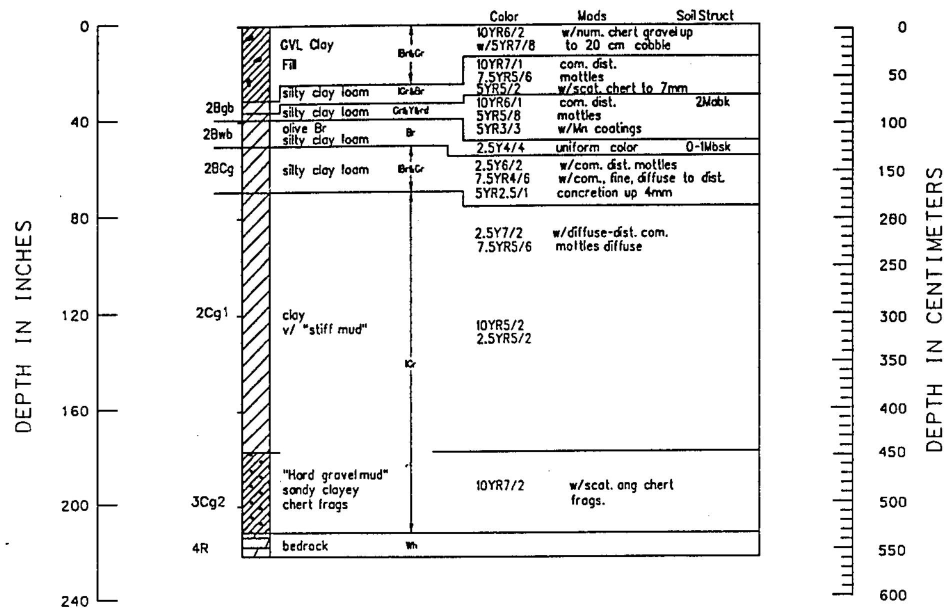
Happy Hollow 2

Fort Leonard Wood


FLW HH-3
13 JUL 93
DEPTH IN INCHES
DEPTH IN CENTIMETERS
Color
Mods
Soil Struct
heavy silt loam
silt loam
clay
clay silt loam
silty clay loam
clay
v/ stiff
bedrock
Happy Hollow 3
Fort Leonard Wood

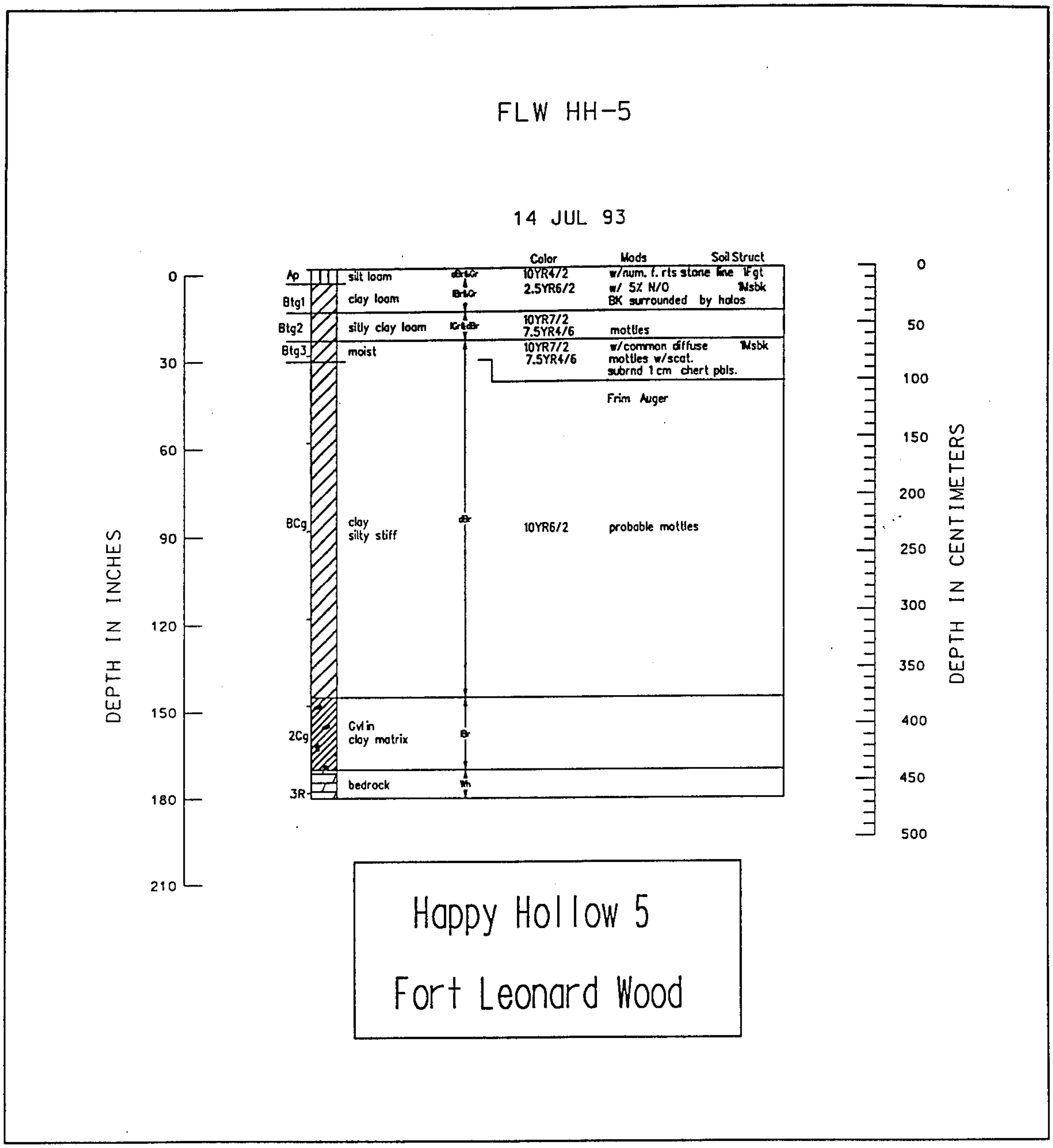
FLW HH-4

13 JUL 93



Happy Hollow 4

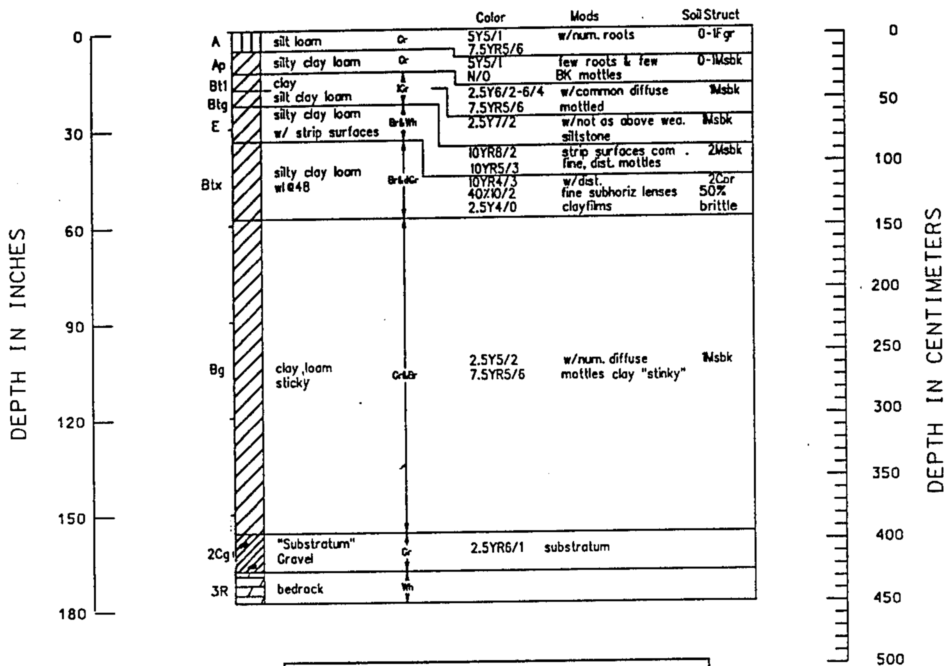
Fort Leonard Wood



FLW HH-5
14 JUL 93
Color
Mods
Soil Struct
Ap
silt loam
10YR4/2
w/num. f. rts stone line
1Fgt
Btg1
clay loam
2.5YR6/2
w/ 5% N/O
1Msbk
BK surrounded by halos
Btg2
sitly clay loam
10YR7/2
7.5YR4/6
mottles
Btg3
moist
10YR7/2
7.5YR4/6
w/common diffuse
1Msbk
mottles w/scat.
subrnd 1 cm chert pbls.
Frim Auger
BCg
clay
silty stiff
10YR6/2
probable mottles
2Cg
Cvl in
clay matrix
3R
bedrock
0
30
60
90
120
150
180
210
DEPTH IN INCHES
0
50
100
150
200
250
300
350
400
450
500
DEPTH IN CENTIMETERS
Happy Hollow 5
Fort Leonard Wood

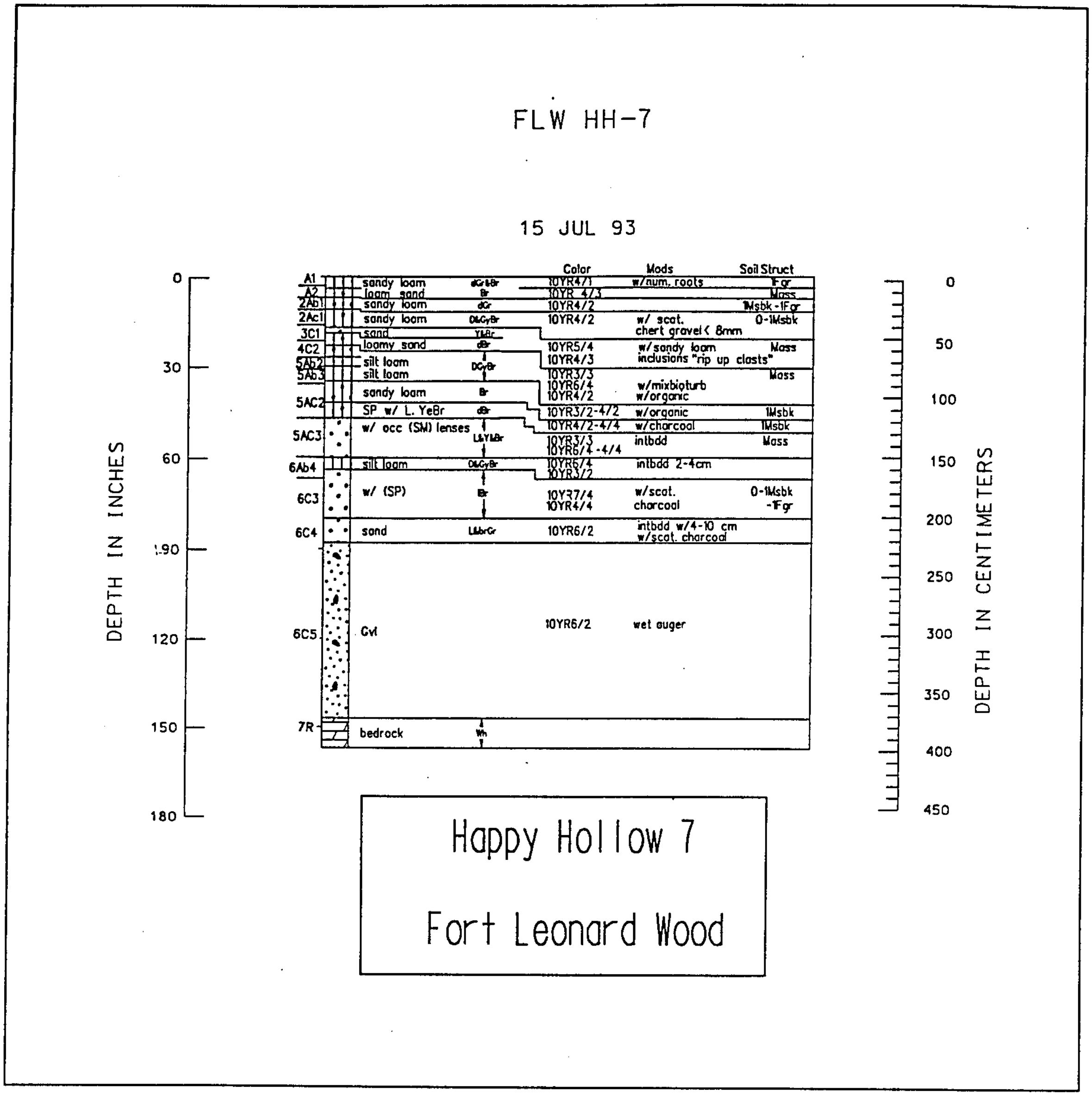
FLW HH-6

14 JUL 93



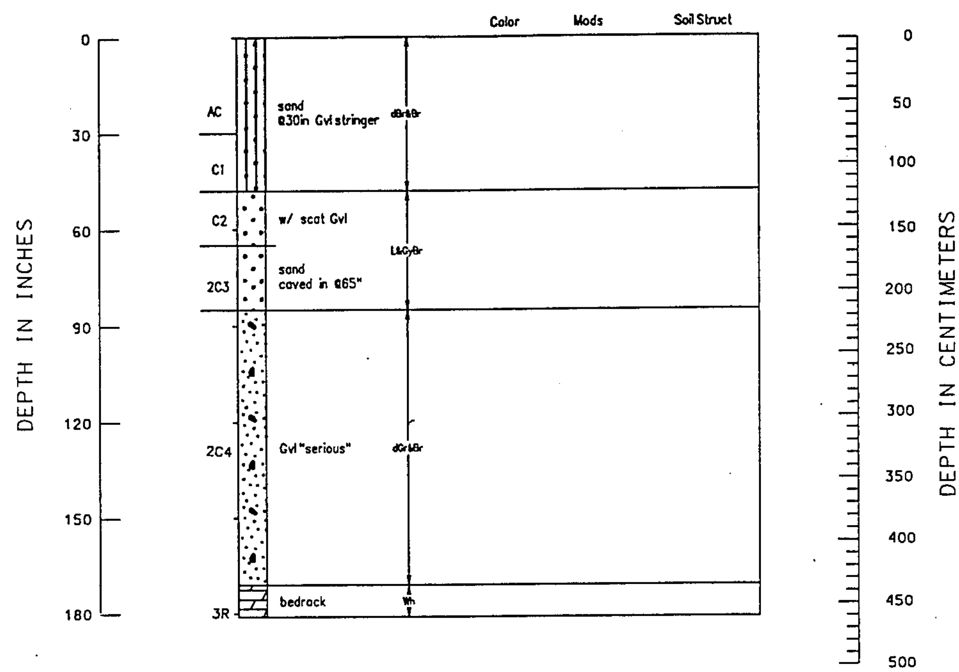
Happy Hollow 6

Fort Leonard Wood

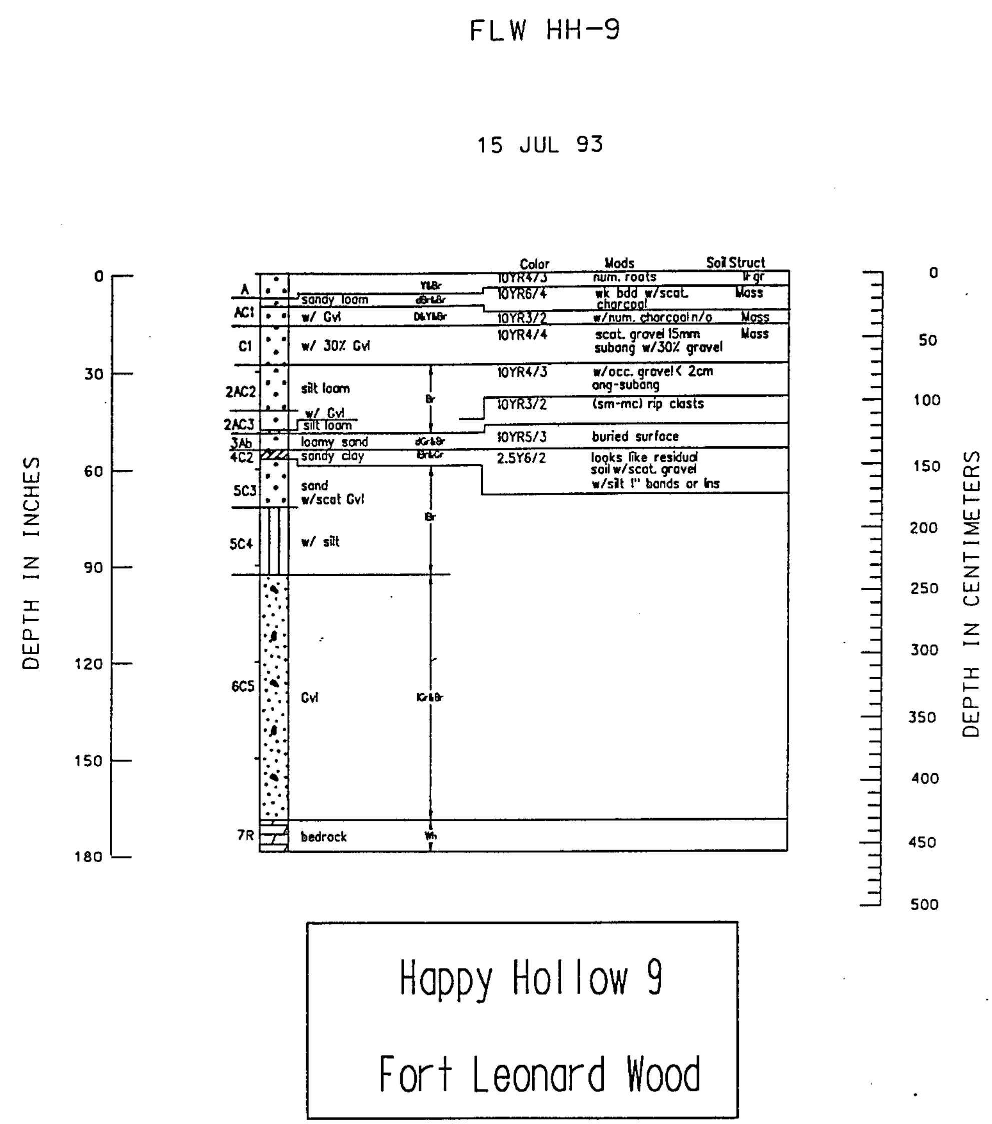

FLW HH-7
15 JUL 93
Color
Mods
Soil Struct
DEPTH IN INCHES
DEPTH IN CENTIMETERS
A1
A2
2Ab1
2Ac1
3C1
4C2
5Ab2
5Ab3
5AC2
5AC3
6Ab4
6C3
6C4
6C5
7R
sandy loam
loam sand
sandy loam
sandy loam
sand
loamy sand
silt loam
silt loam
sandy loam
SP w/ L. YeBr
w/ occ (SM) lenses
silt loam
w/ (SP)
sand
Gvl
bedrock
10YR4/1
10YR 4/3
10YR4/2
10YR4/2
10YR5/4
10YR4/3
10YR3/3
10YR6/4
10YR4/2
10YR3/2-4/2
10YR4/2-4/4
10YR3/3
10YR6/4-4/4
10YR6/4
10YR3/2
10YR7/4
10YR4/4
10YR6/2
10YR6/2
w/num. roots
w/ scat. chert gravel < 8mm
w/sandy loam inclusions "rip up clasts"
w/mixbioturb
w/organic
w/organic
w/charcoal
intbdd
intbdd 2-4cm
w/scat. charcoal
intbdd w/4-10 cm w/scat. charcoal
wet auger
Mass
0-1Msbk
Mass
Mass
1Msbk
1Msbk
Mass
0-1Msbk
Happy Hollow 7
Fort Leonard Wood

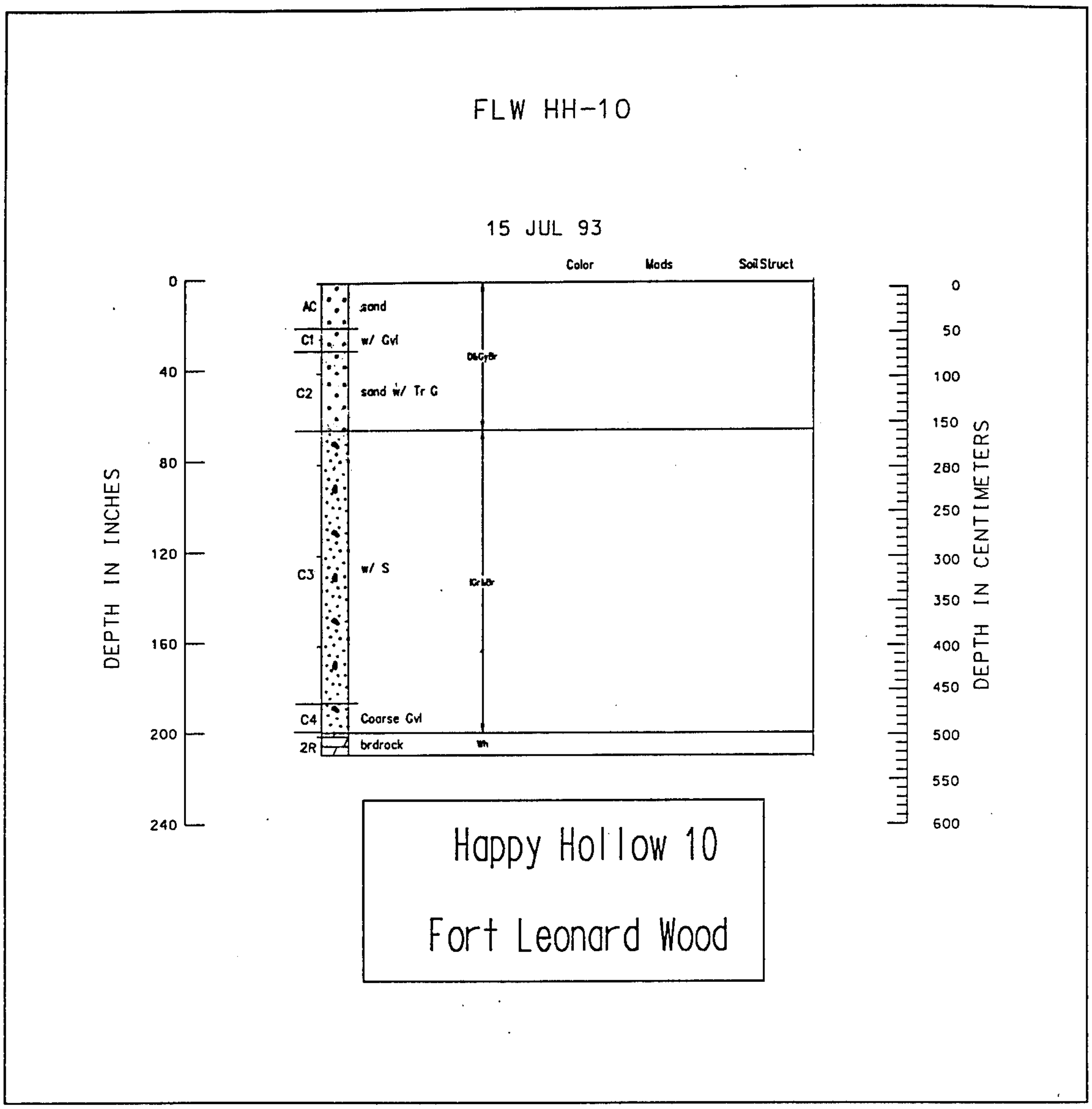
FLW HH-8

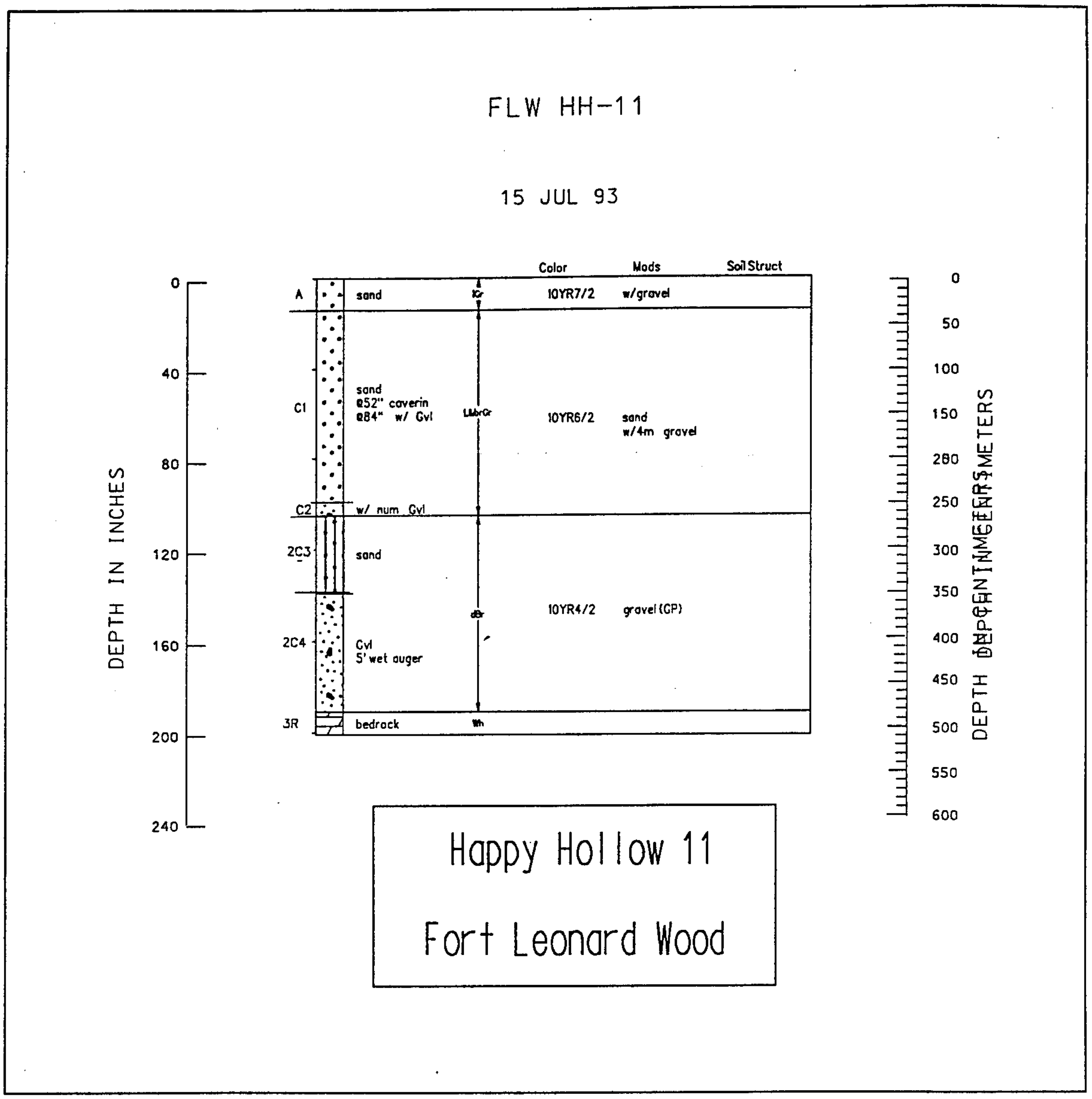
15 JUL 93

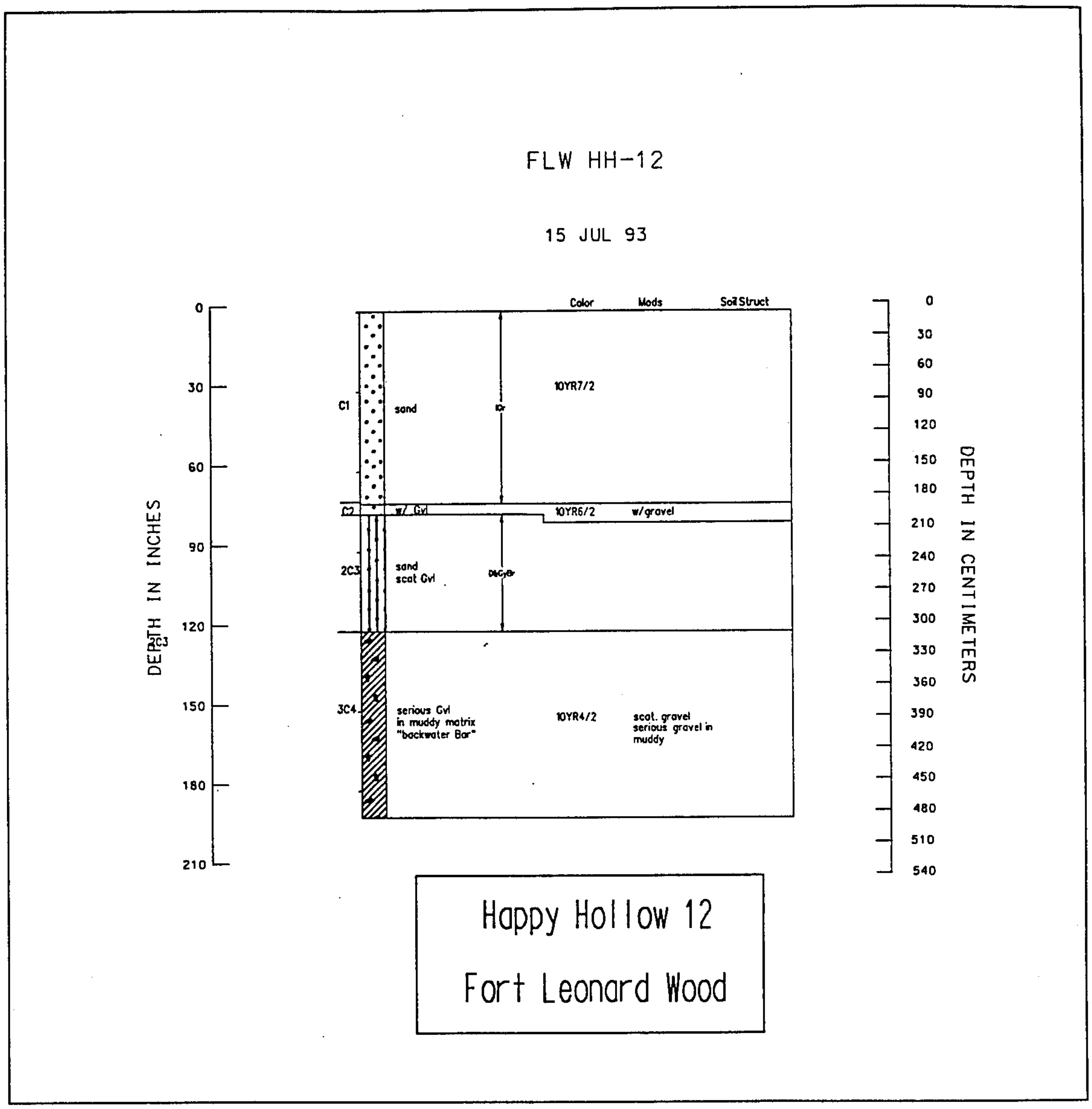


Happy Hollow 8
Fort Leonard Wood


FLW HH-9
15 JUL 93
Color
Mods
Soil Struct
10YR4/3
num. roots
10YR6/4
wk bdd w/scat. charcoal
Mass
10YR3/2
w/num. charcoal n/o
Mass
10YR4/4
scat. gravel 15mm subang w/30% gravel
Mass
10YR4/3
w/occ. gravel < 2cm ang-subang
10YR3/2
(sm-mc) rip clasts
10YR5/3
buried surface
2.5Y6/2
looks like residual soil w/scat. gravel w/silt 1" bands or lns
A
AC1
C1
2AC2
2AC3
3Ab
4C2
5C3
5C4
6C5
7R
sandy loam
w/ Gvl
w/ 30% Gvl
silt loam
w/ Gvl
silt loam
loamy sand
sandy clay
sand w/scat Gvl
w/ silt
Gvl
bedrock
DEPTH IN INCHES
0
30
60
90
120
150
180
DEPTH IN CENTIMETERS
0
50
100
150
200
250
300
350
400
450
500
Happy Hollow 9
Fort Leonard Wood

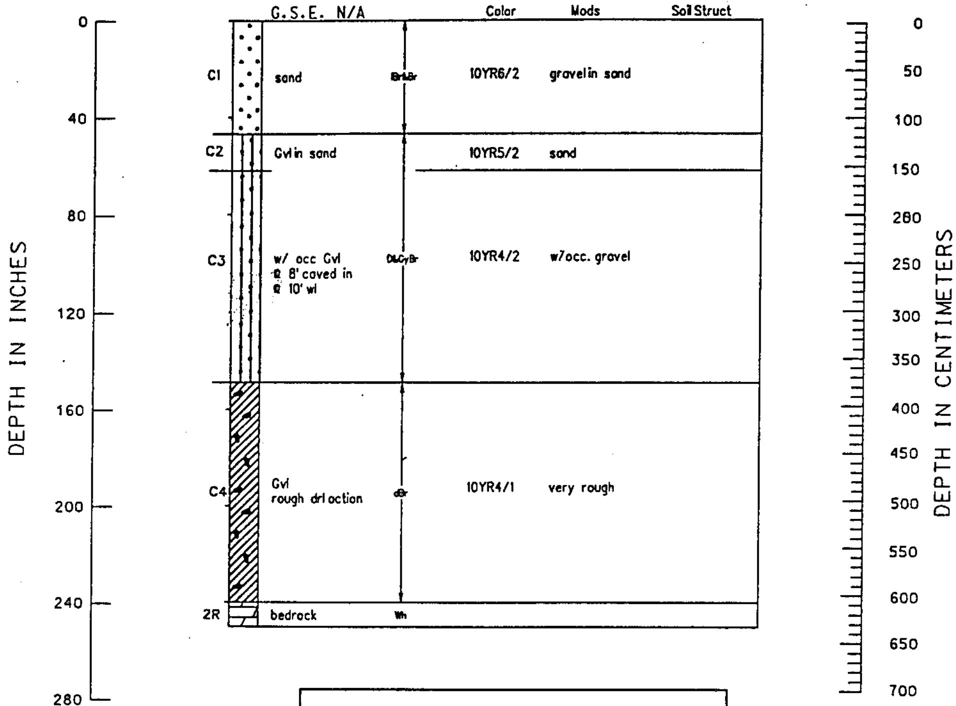

FLW HH-10
15 JUL 93
Color
Mods
Soil Struct
DEPTH IN INCHES
0
40
80
120
160
200
240
AC
sand
C1
w/ Gvl
C2
sand w/ Tr G
C3
w/ S
C4
Coarse Gvl
2R
brdrock
DEPTH IN CENTIMETERS
0
50
100
150
200
250
300
350
400
450
500
550
600
Happy Hollow 10
Fort Leonard Wood


FLW HH-11
15 JUL 93
Color
Mods
Soil Struct
DEPTH IN INCHES
0
40
80
120
160
200
240
A
sand
10YR7/2
w/gravel
C1
sand
@52" caverin
@84" w/ Gvl
10YR6/2
sand
w/4m gravel
C2
w/ num Gvl
2C3
sand
2C4
Gvl
5' wet auger
10YR4/2
gravel (GP)
3R
bedrock
DEPTH IN CENTIMETERS
0
50
100
150
200
250
300
350
400
450
500
550
600
Happy Hollow 11
Fort Leonard Wood


FLW HH-12
15 JUL 93
Color
Mods
Soil Struct
C1
sand
10YR7/2
C2
w/ Gvl
10YR6/2
w/gravel
2C3
sand
scat Gvl
3C4
serious Gvl
in muddy matrix
"backwater Bar"
10YR4/2
scat. gravel
serious gravel in
muddy
DEPTH IN INCHES
0
30
60
90
120
150
180
210
DEPTH IN CENTIMETERS
0
30
60
90
120
150
180
210
240
270
300
330
360
390
420
450
480
510
540
Happy Hollow 12
Fort Leonard Wood

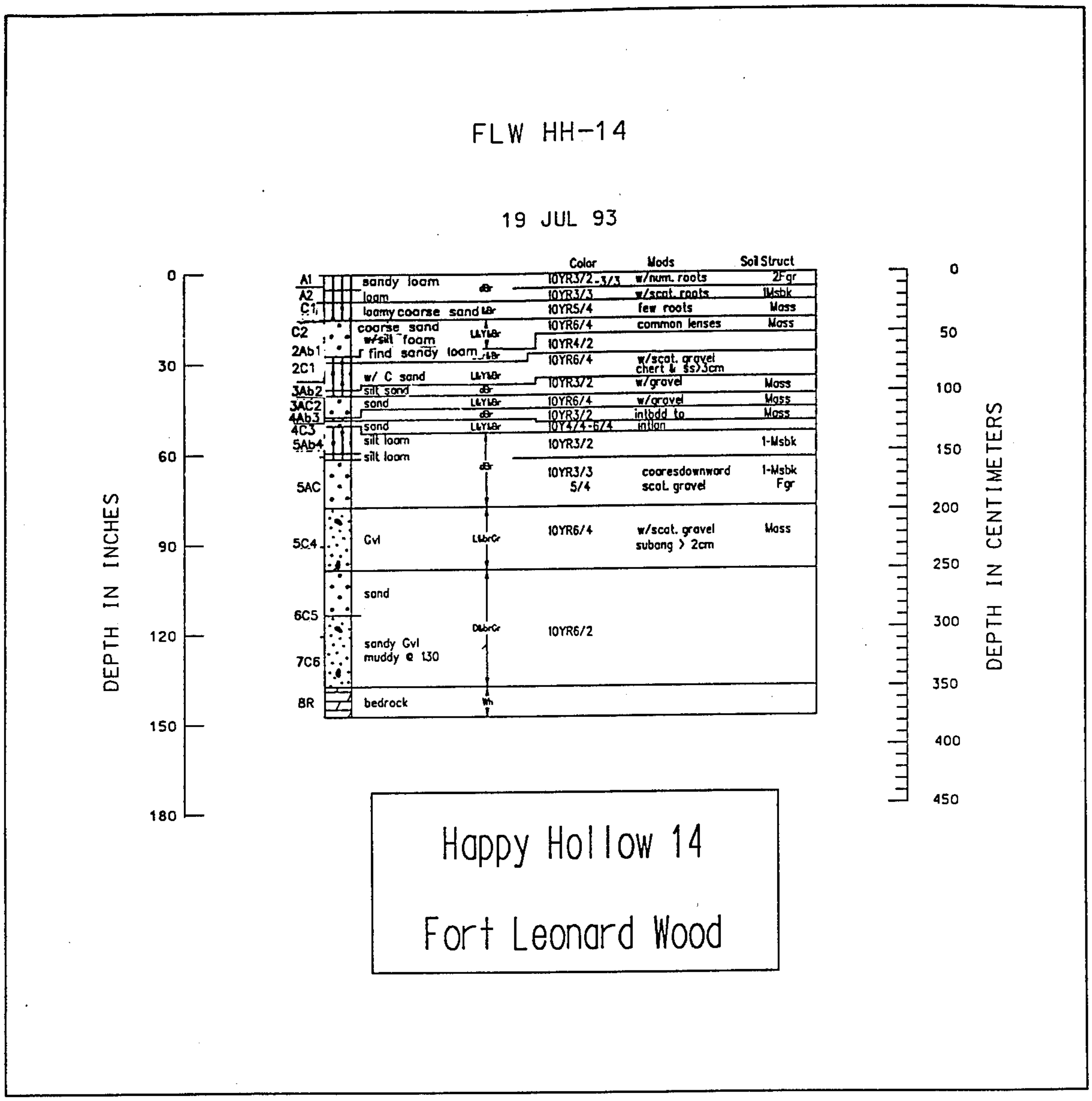
FLW HH-13

15 JUL 93



Happy Hollow 13

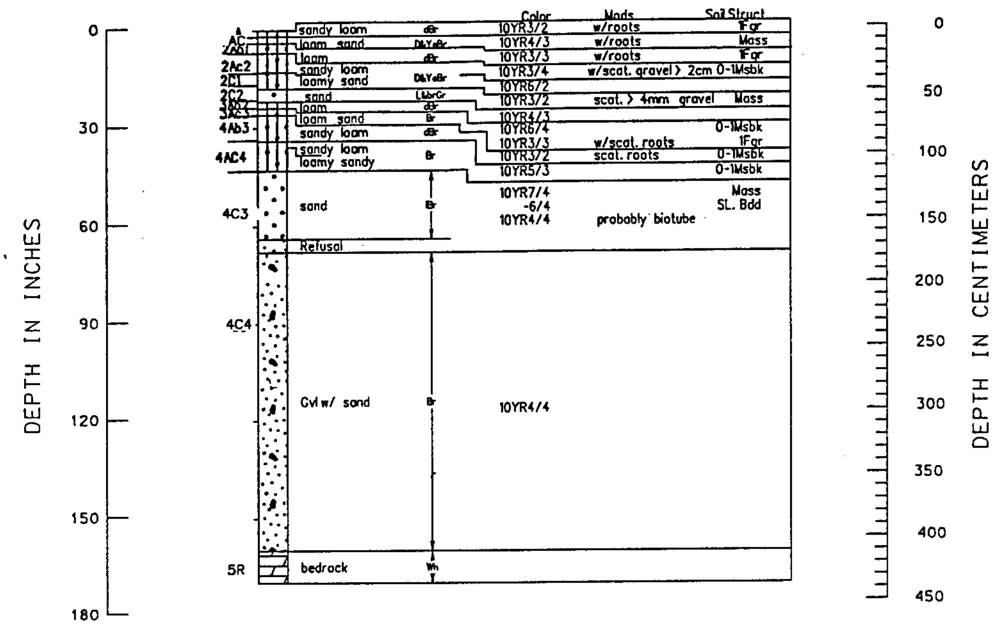
Fort Leonard Wood



FLW HH-14
19 JUL 93
DEPTH IN INCHES
DEPTH IN CENTIMETERS
Happy Hollow 14
Fort Leonard Wood

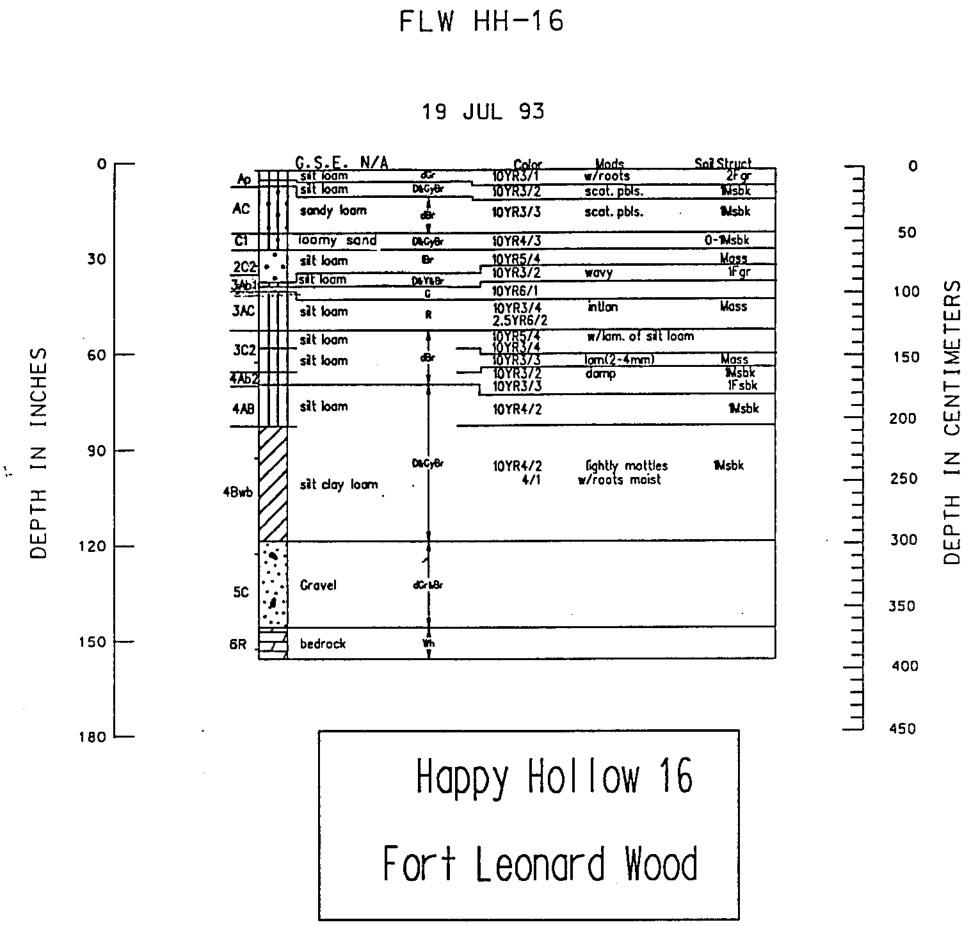
FLW HH-15

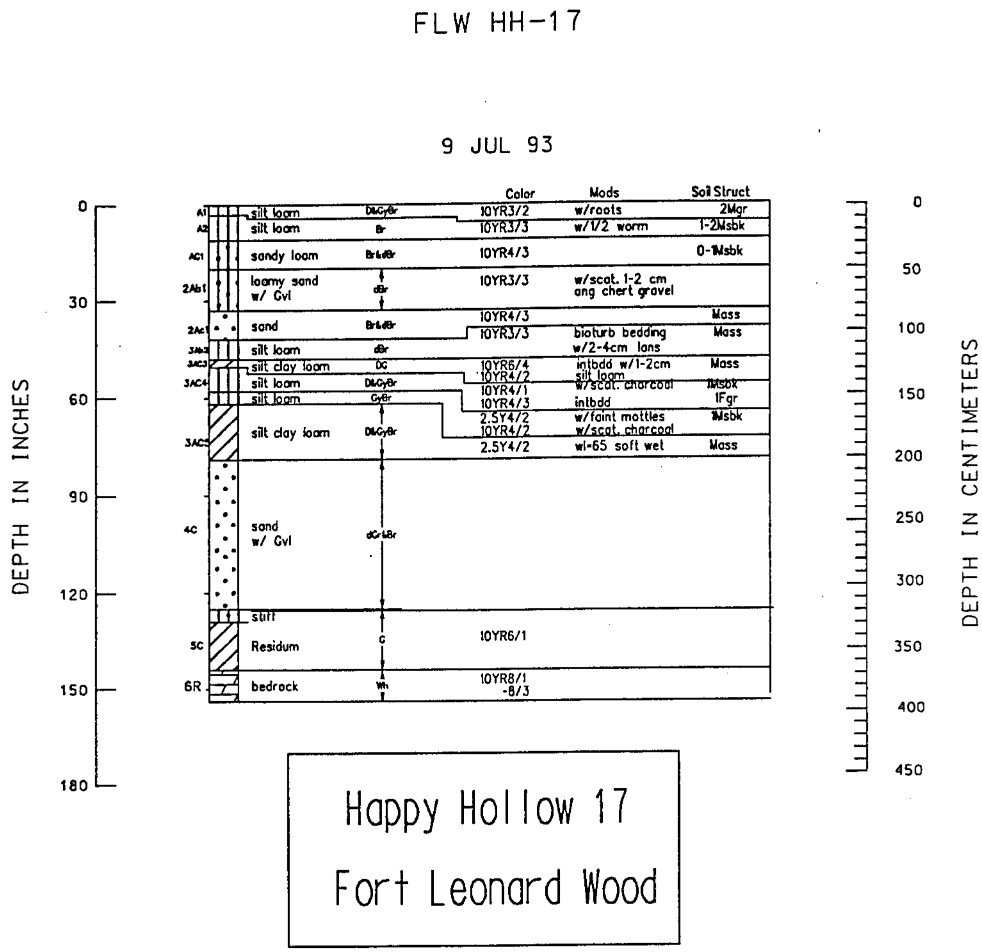
15 JUL 93



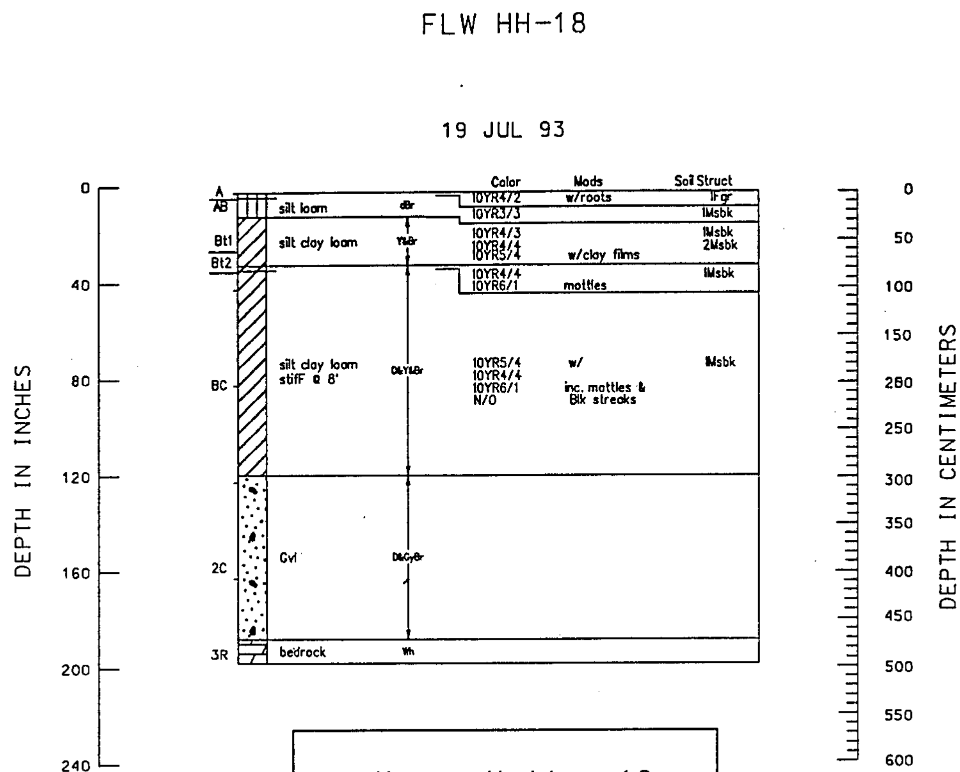
Happy Hollow 15

Fort Leonard Wood


FLW HH-16
19 JUL 93
G.S.E. N/A
DEPTH IN INCHES
DEPTH IN CENTIMETERS
silt loam
sandy loam
loamy sand
silt clay loam
Gravel
bedrock
Happy Hollow 16
Fort Leonard Wood



FLW HH-17
9 JUL 93
Color
Mods
Soil Struct
DEPTH IN INCHES
DEPTH IN CENTIMETERS
silt loam
sandy loam
loamy sand w/ Gvl
sand
silt clay loam
silt clay loam
sand w/ Gvl
Residum
bedrock
10YR3/2
10YR3/3
10YR4/3
w/roots
w/1/2 worm
w/scat. 1-2 cm ang chert gravel
bioturb bedding w/2-4cm lons
w/faint mottles
w/scat. charcoal
2.5Y4/2
wl-65 soft wet
10YR6/1
10YR8/1 -8/3
Happy Hollow 17
Fort Leonard Wood

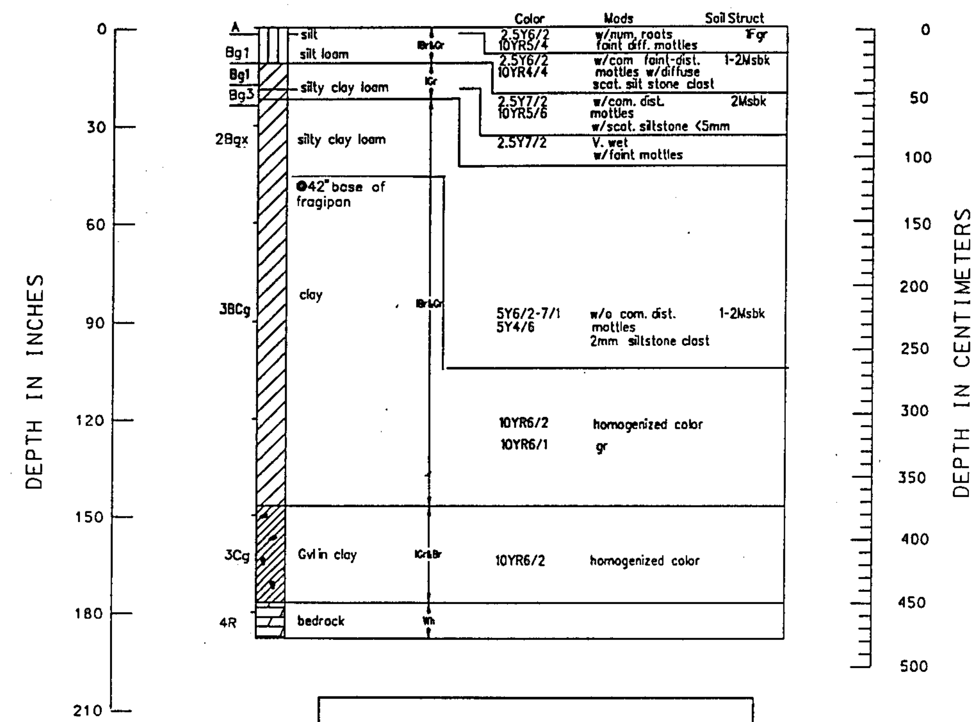


Happy Hollow 18

Fort Leonard Wood

FLW HH-19

19 JUL 93

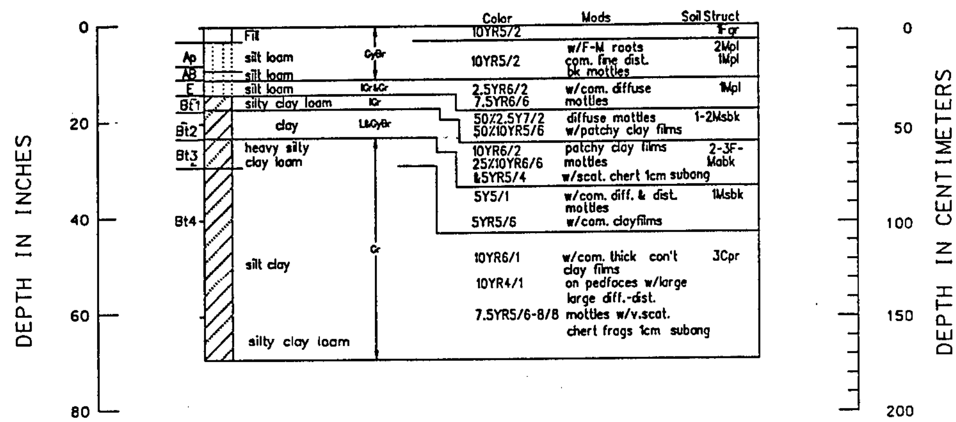


Happy Hollow 19

Fort Leonard Wood

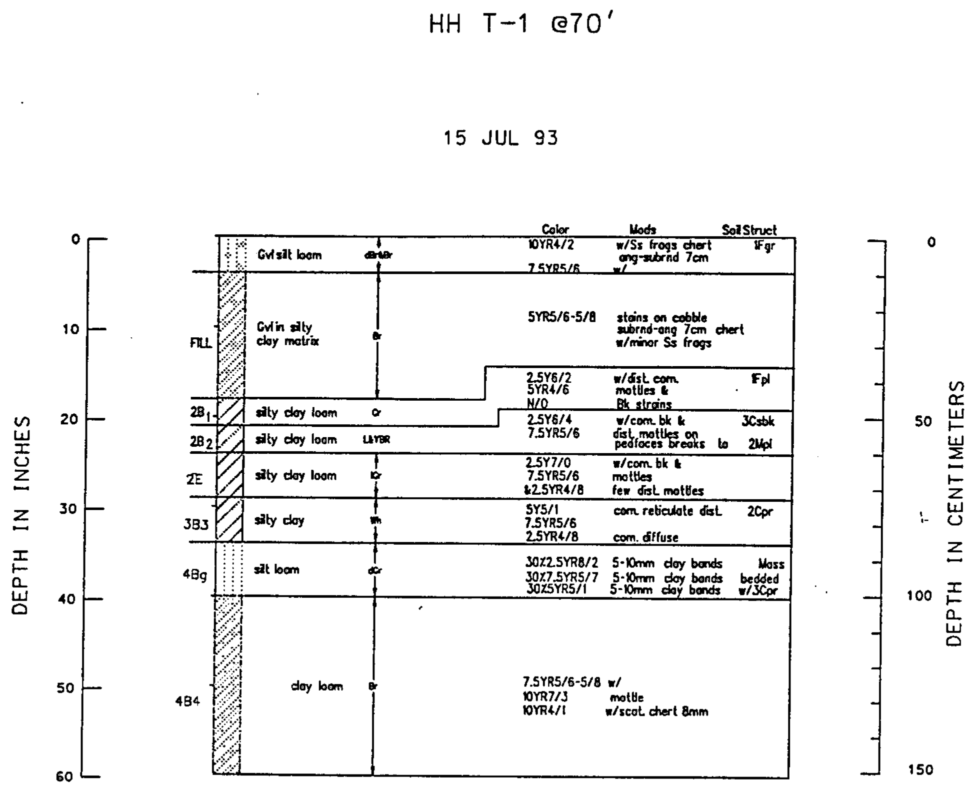
HH T-1 @20'

15 JUL 93



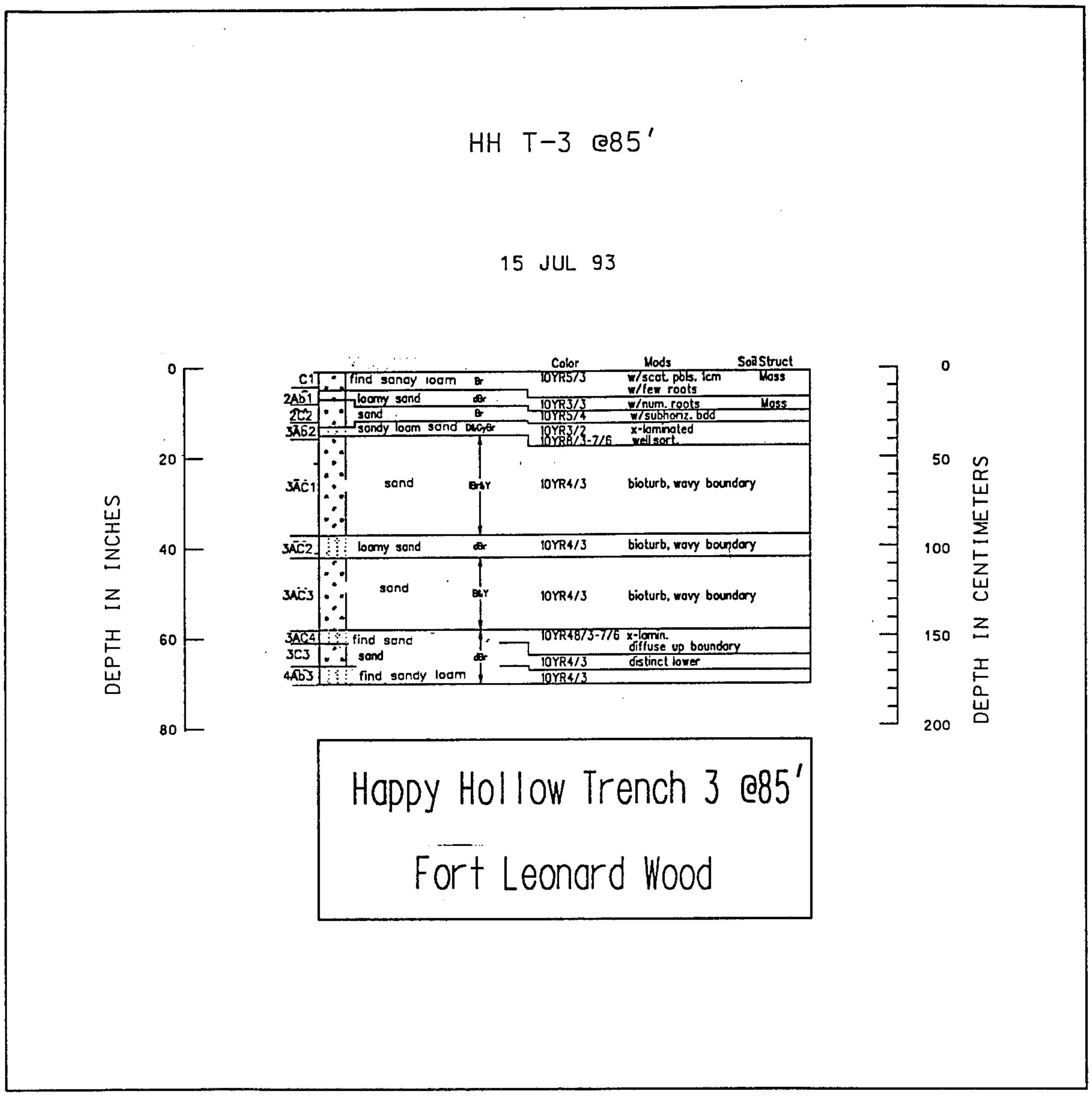
Happy Hollow Trench 1 @20'

Fort Leonard Wood

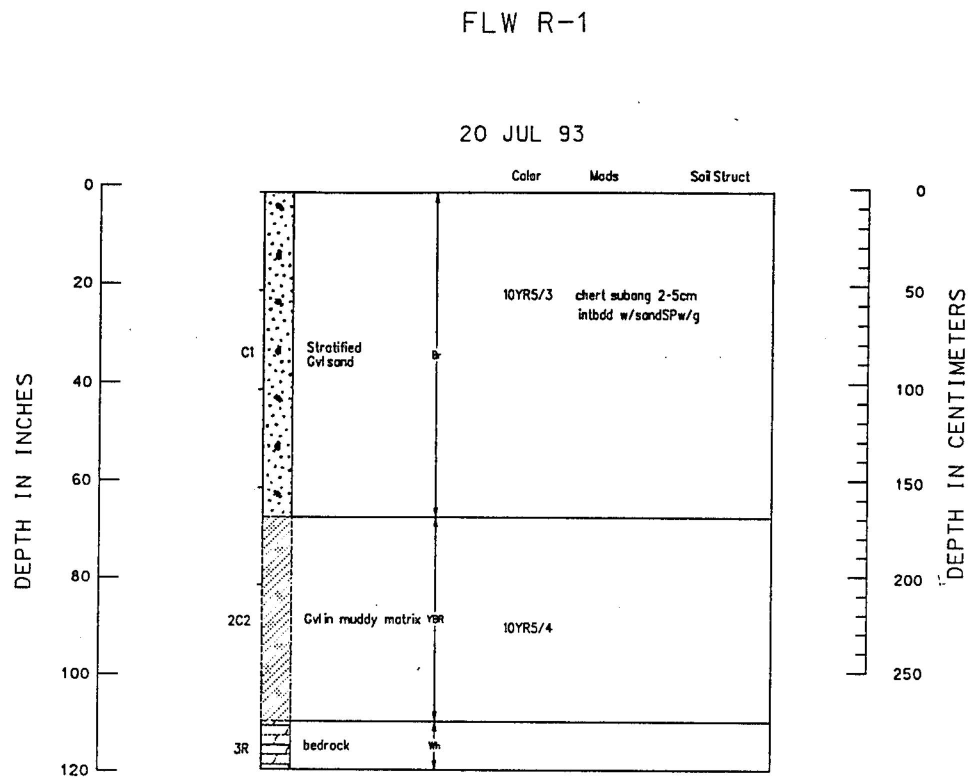


Happy Hollow Trench 1 @70'

Fort Leonard Wood

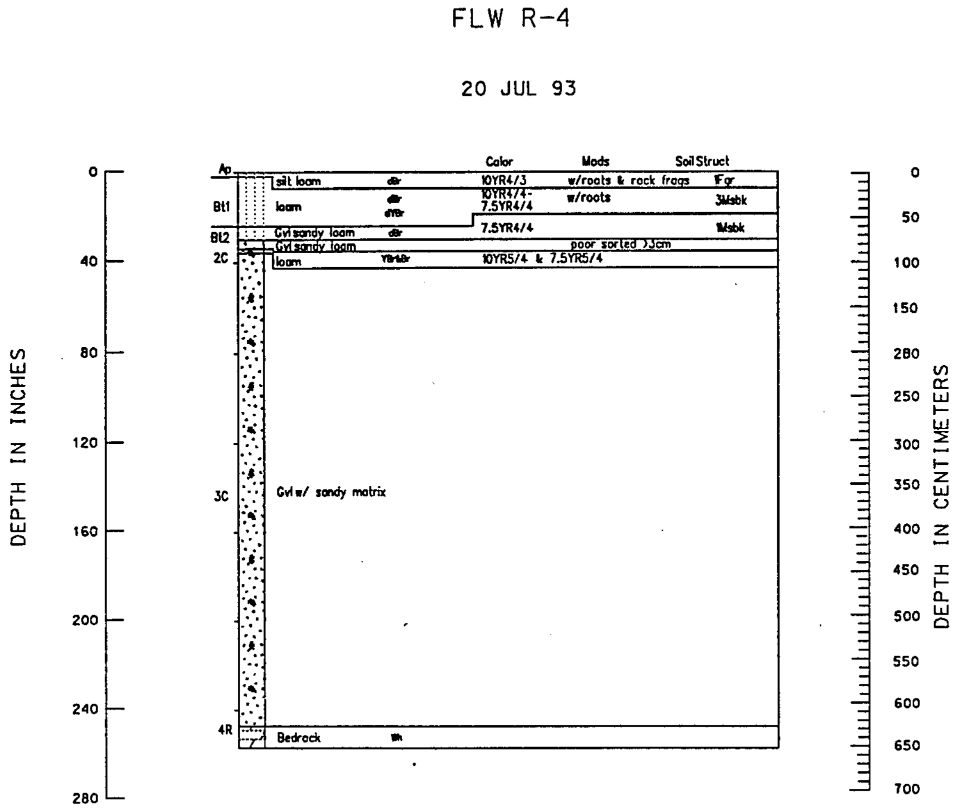


HH T-3 @85'
15 JUL 93
DEPTH IN INCHES
DEPTH IN CENTIMETERS
Color
Mods
Soil Struct
C1 find sandy loam Br 10YR5/3 w/scat. pbls. 1cm w/few roots Mass
2Ab1 loamy sand dBr 10YR3/3 w/num. roots Mass
2C2 sand Br 10YR5/4 w/subhoriz. bdd
3Ab2 sandy loam sand 10YR3/2 10YR8/3-7/6 x-laminated well sort.
3AC1 sand 10YR4/3 bioturb, wavy boundary
3AC2 loamy sand dBr 10YR4/3 bioturb, wavy boundary
3AC3 sand 10YR4/3 bioturb, wavy boundary
3AC4 find sand 10YR48/3-7/6 x-lamin. diffuse up boundary
3C3 sand dBr 10YR4/3 distinct lower
4Ab3 find sandy loam 10YR4/3
Happy Hollow Trench 3 @85'
Fort Leonard Wood



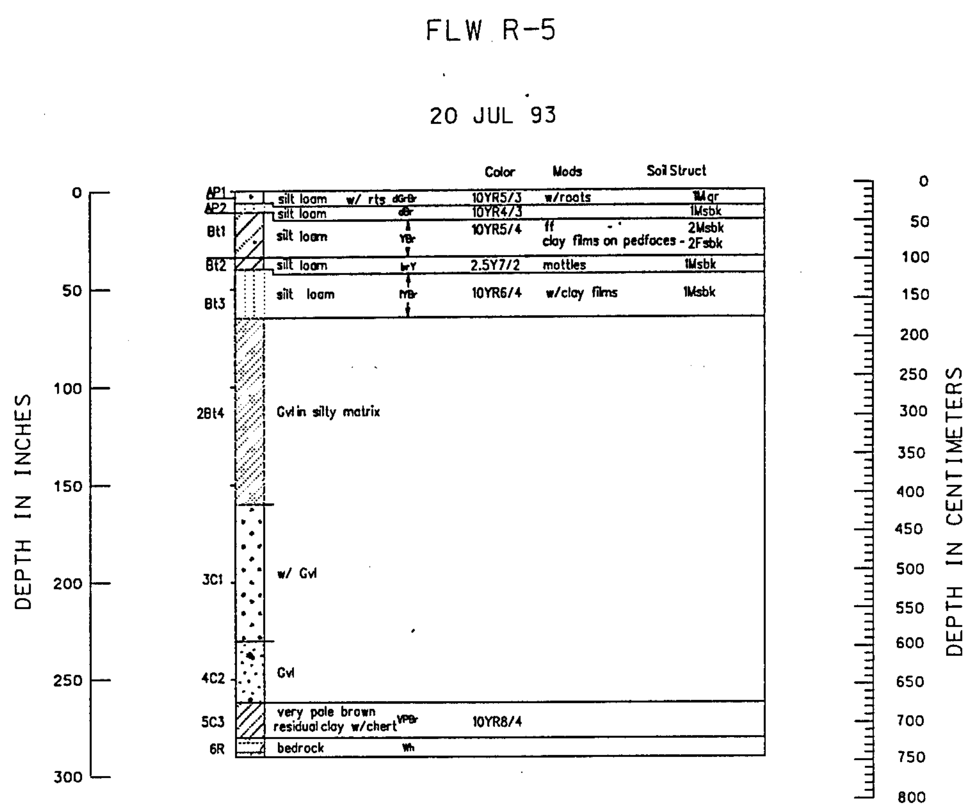
Roubidoux 1

Fort Leonard Wood



Roubidoux 4

Fort Leonard Wood

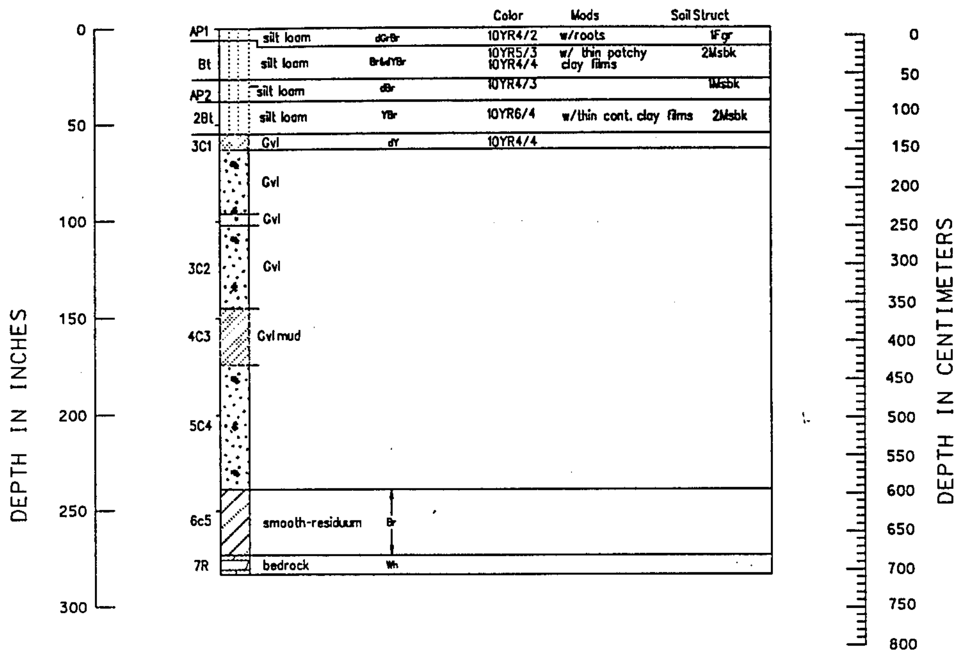


Roubidoux 5

Fort Leonard Wood

FLW R-6

21 JUL 93

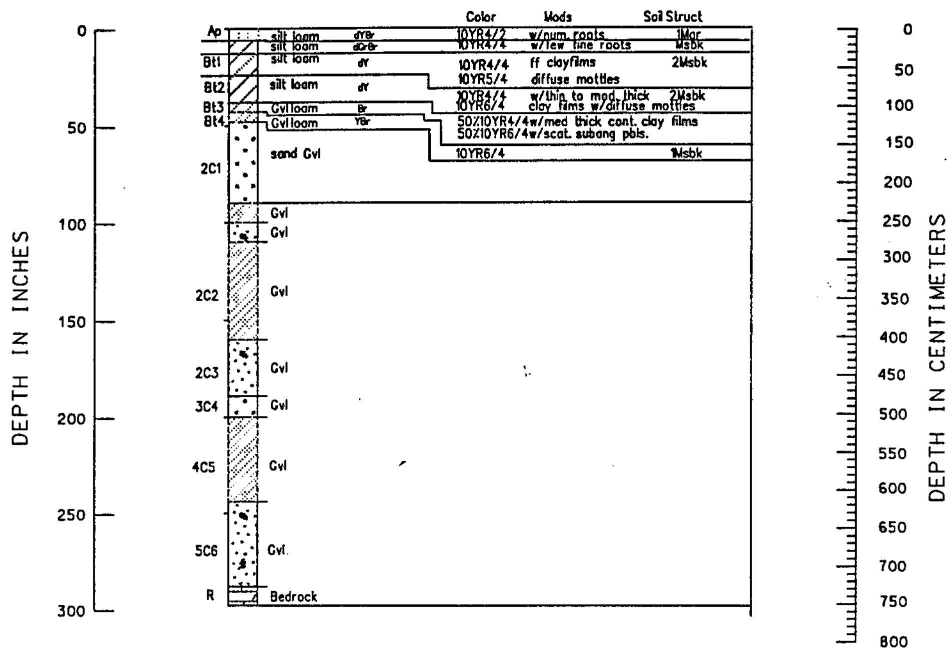


Roubidoux 6

Fort Leonard Wood

FLW R-7

21 JUL 93

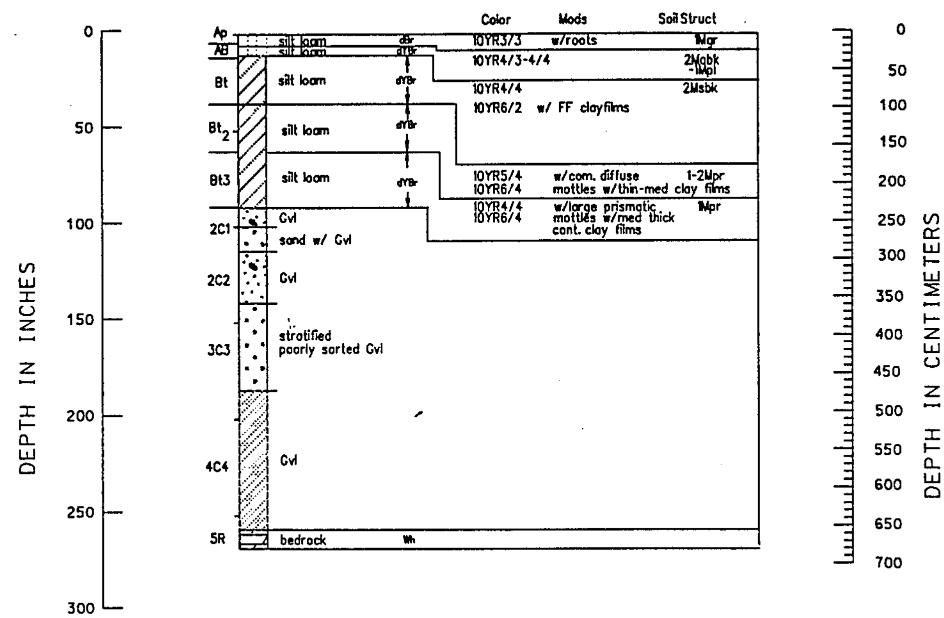


Roubidoux 7

Fort Leonard Wood

FLW R-8

21 JUL 93

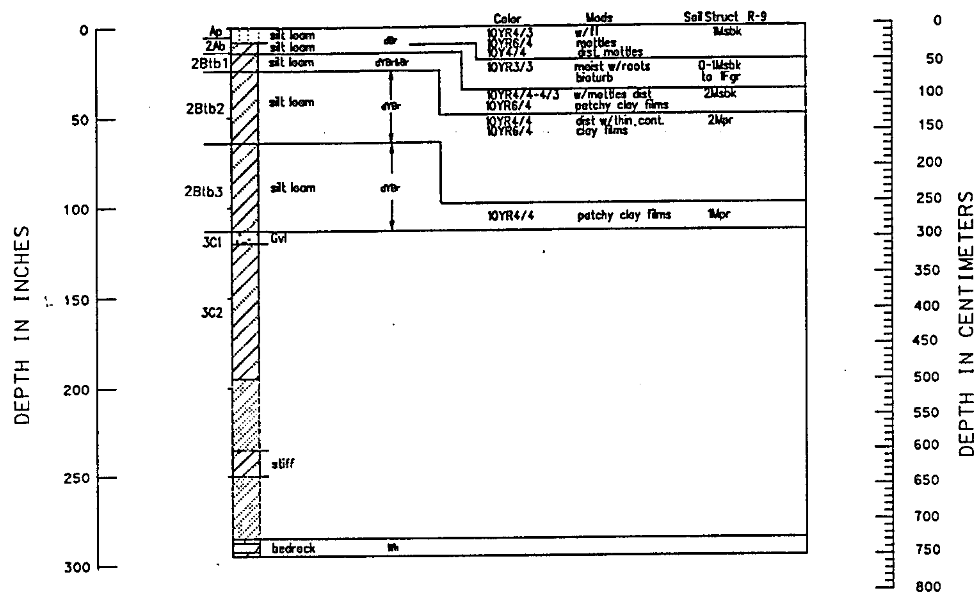


Roubidoux 8

Fort Leonard Wood

FLW R-9

21 JUL 93

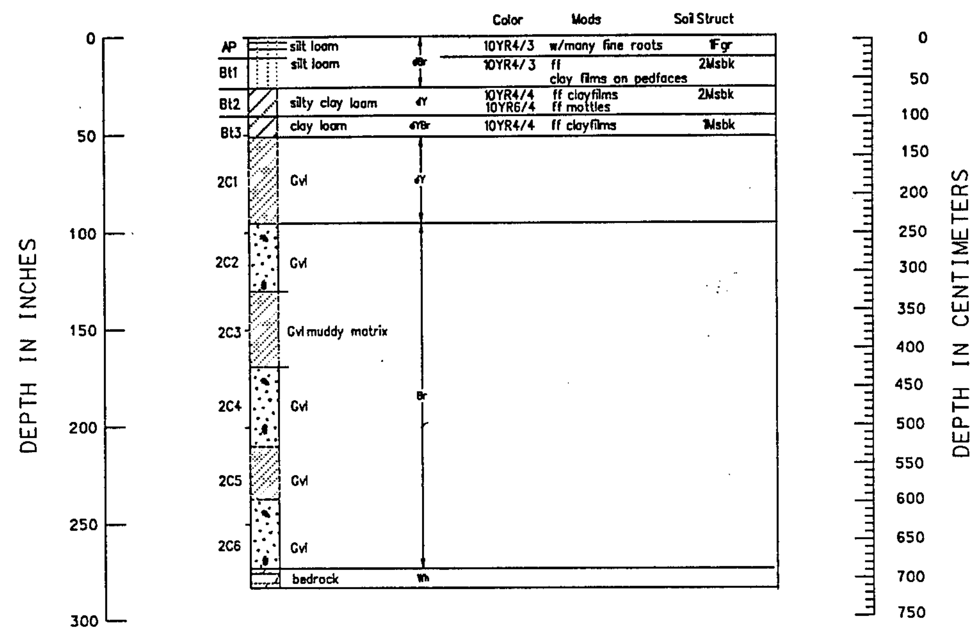


Roubidoux 9

Fort Leonard Wood

FLW R-10

21 JUL 93

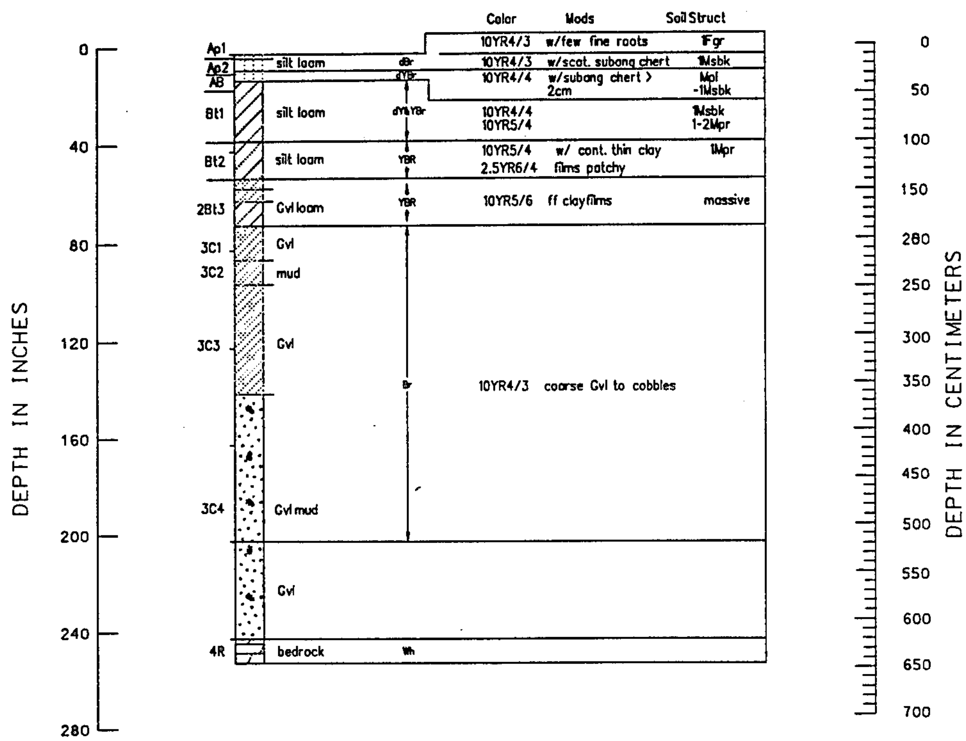


Roubidoux 10

Fort Leonard Wood

FLW R-11

21 JUL 93

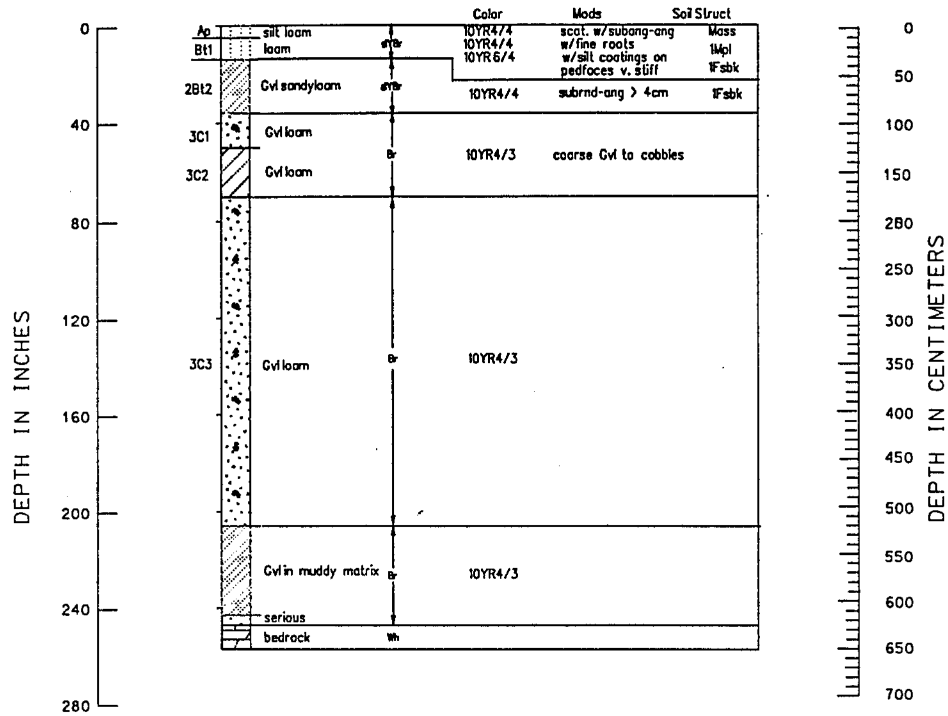


Roubidoux 11

Fort Leonard Wood

FLW R-12

21 JUL 93

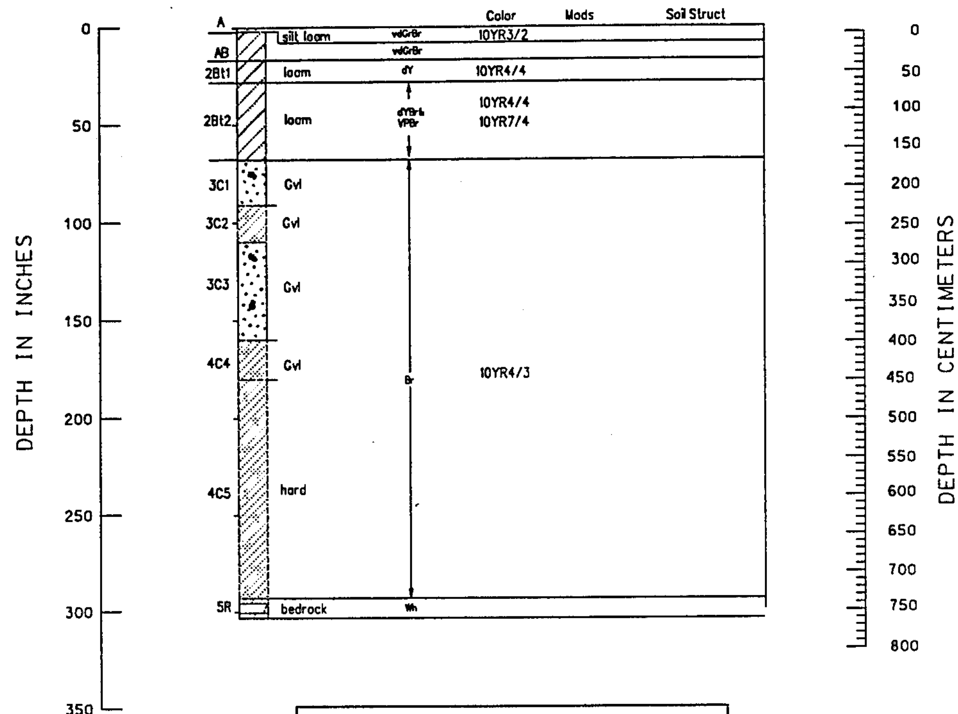


Roubidoux 12

Fort Leonard Wood

FLW R-13

21 JUL 93

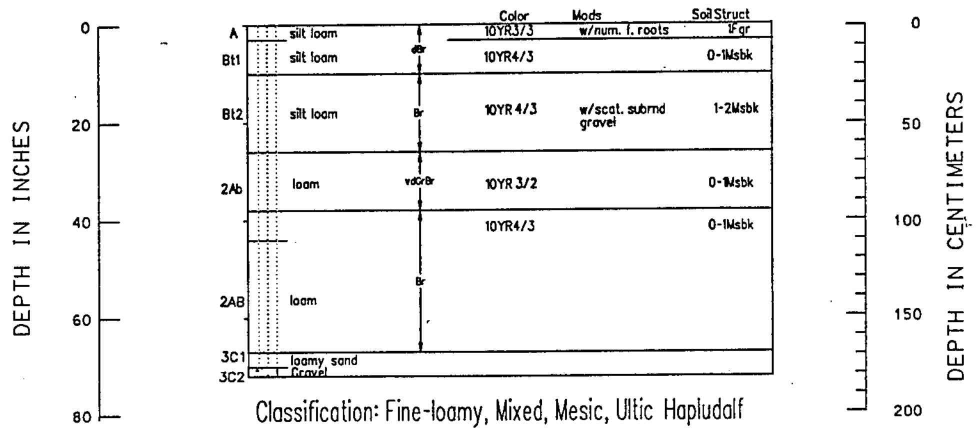


Roubidoux 13

Fort Leonard Wood

RT-1@65'

21 JUL 93



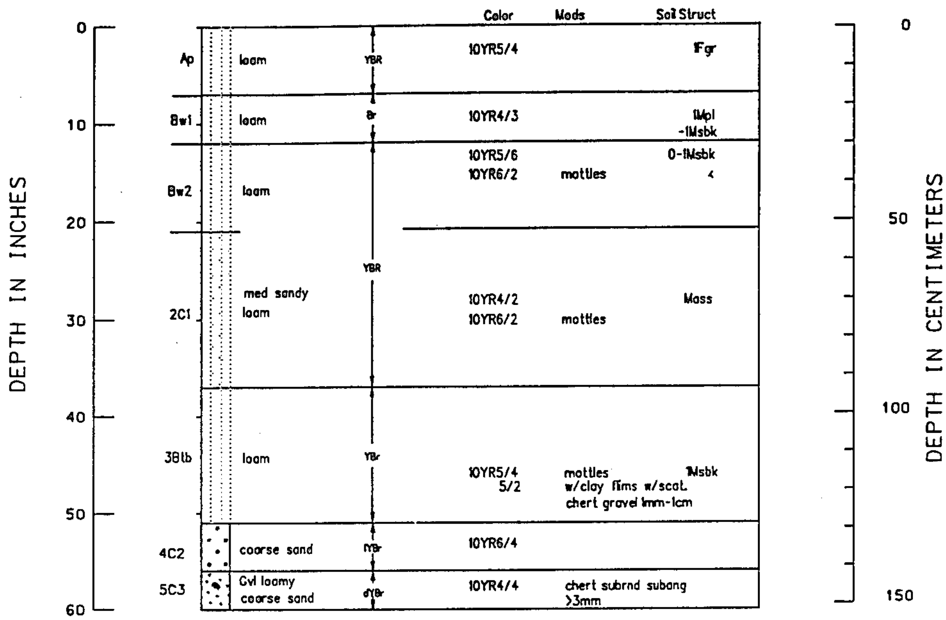
Classification: Fine-loamy, Mixed, Mesic, Ultic Hapludalf

Roubidoux Trench 1 @ 65'

Fort Leonard Wood

RT-1@130

21 JUL 93



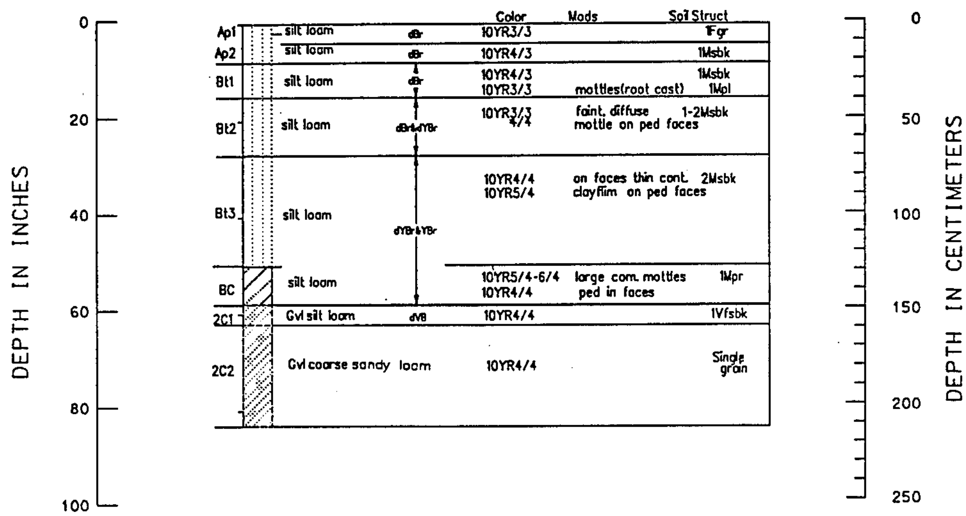
Classification: Coarse-loamy, Siliceous, Mesic, Dytric, Fluventic Eutrocrept

Roubidoux T-1 @ 130'

Fort Leonard Wood

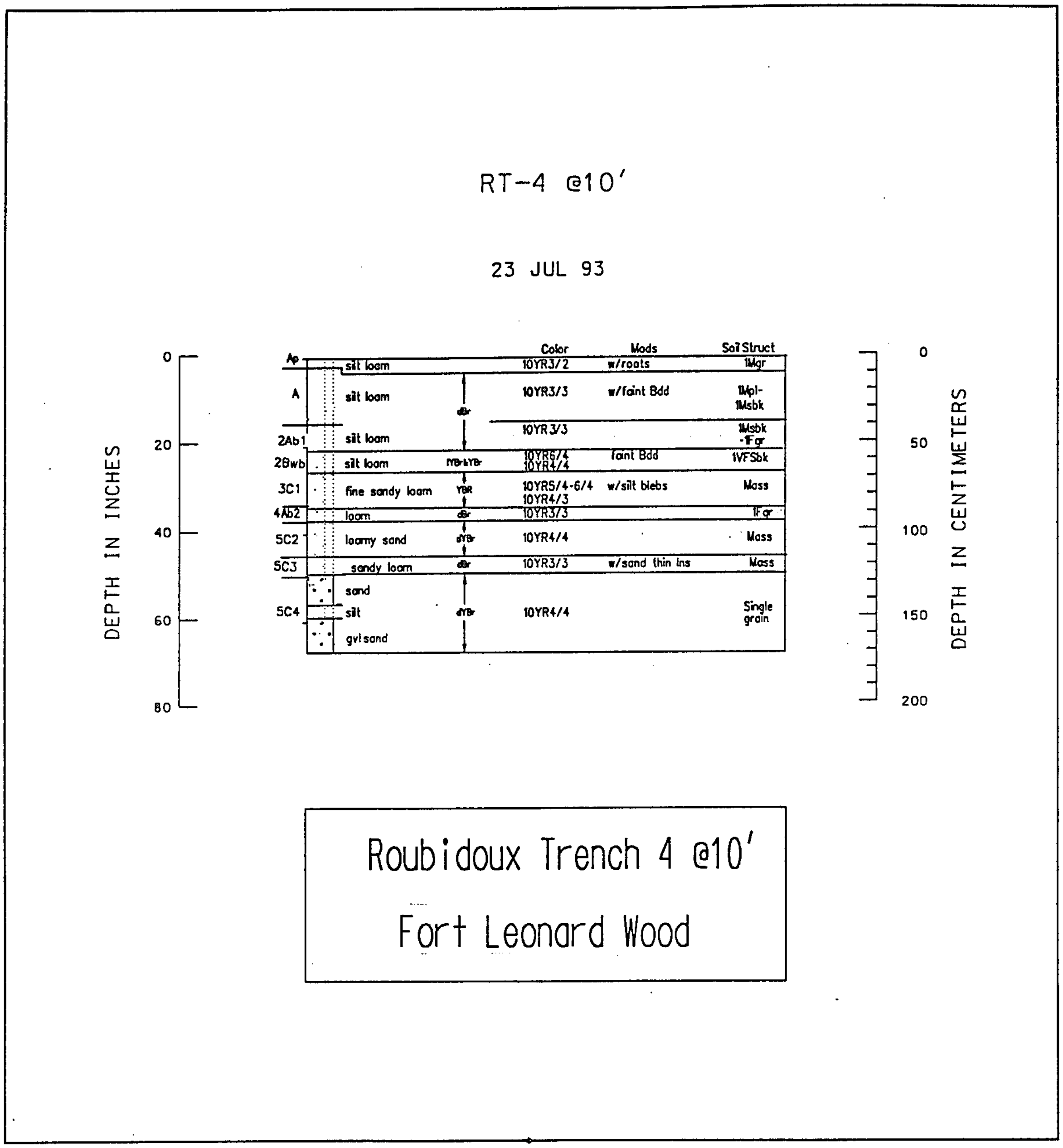
RT-2@30'

21 JUL 94



Roubidoux T-2 @ 30

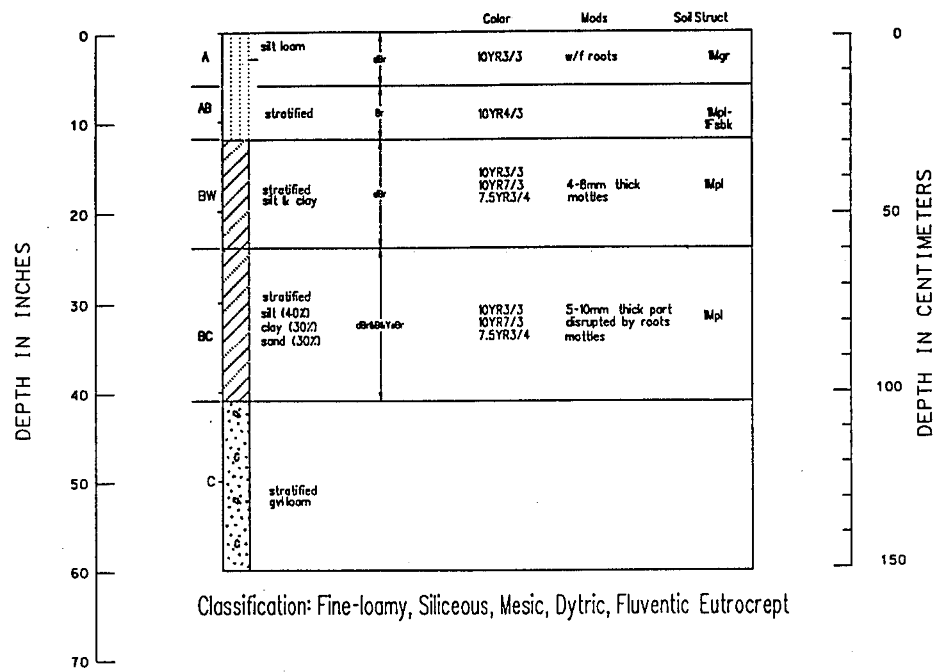
Fort Leonard Wood



RT-4 @10'
23 JUL 93
Color
Mods
Soil Struct
Ap
silt loam
10YR3/2
w/roots
A
silt loam
10YR3/3
w/faint Bdd
2Ab1
silt loam
10YR3/3
2Bwb
silt loam
3C1
fine sandy loam
10YR5/4-6/4
10YR4/3
w/silt blebs
Mass
4Ab2
loam
10YR3/3
5C2
loamy sand
10YR4/4
Mass
5C3
sandy loam
10YR3/3
w/sand thin lns
Mass
5C4
sand
silt
gvl sand
10YR4/4
Single grain
DEPTH IN INCHES
DEPTH IN CENTIMETERS
Roubidoux Trench 4 @10'
Fort Leonard Wood

RT-4 @71'

23 JUL 93



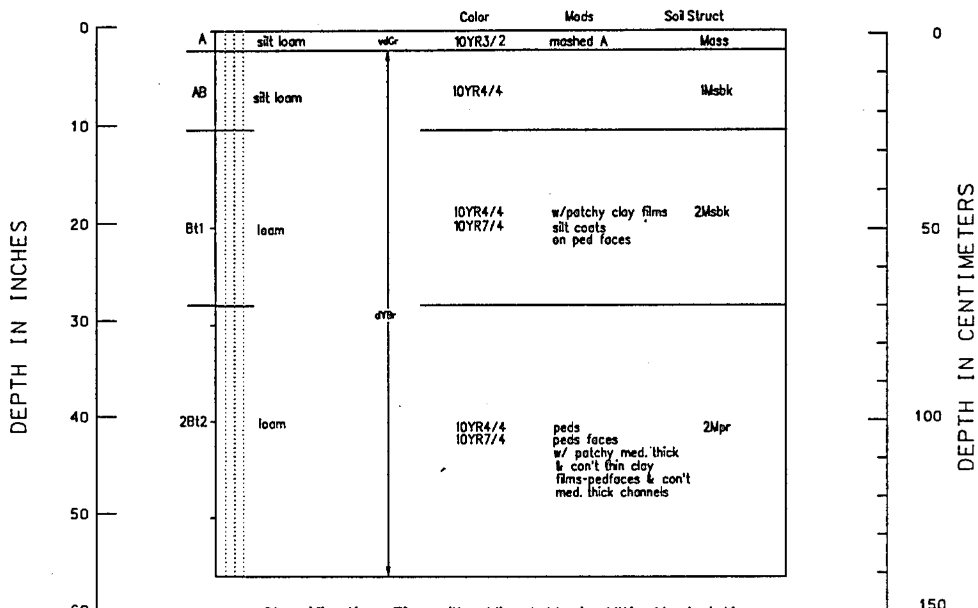
Classification: Fine-loamy, Siliceous, Mesic, Dytric, Fluventic Eutrocrept

Roubidoux Trench 4 @ 71'

Fort Leonard Wood

RT-4 @100'

23 JUL 93



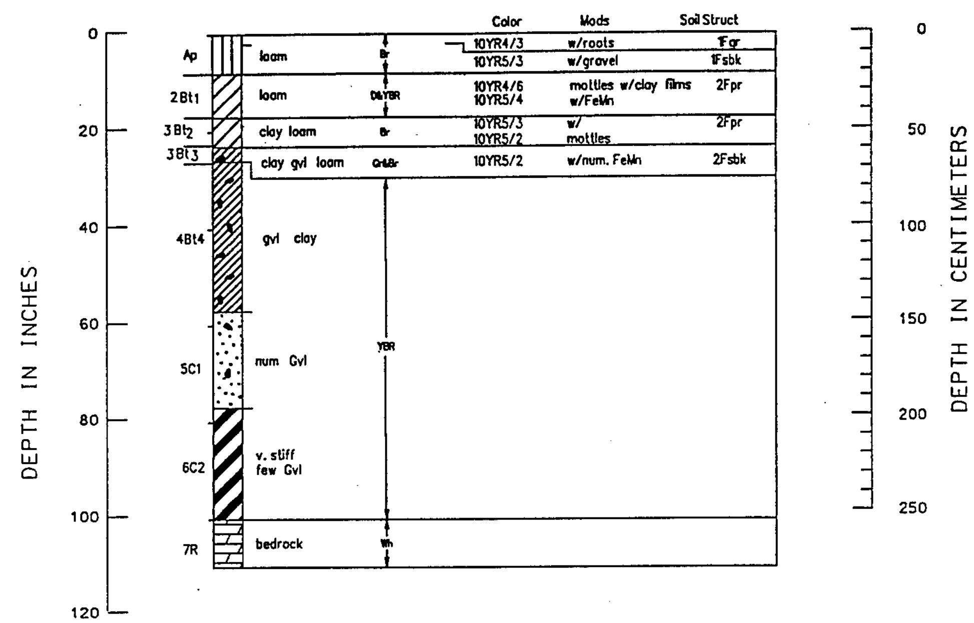
Classification: Fine-silty, Mixed, Mesic, Ultic Hapludalf

Roubidoux Trench 4 @100'

Fort Leonard Wood

FLW UR-1

19 OCT 93

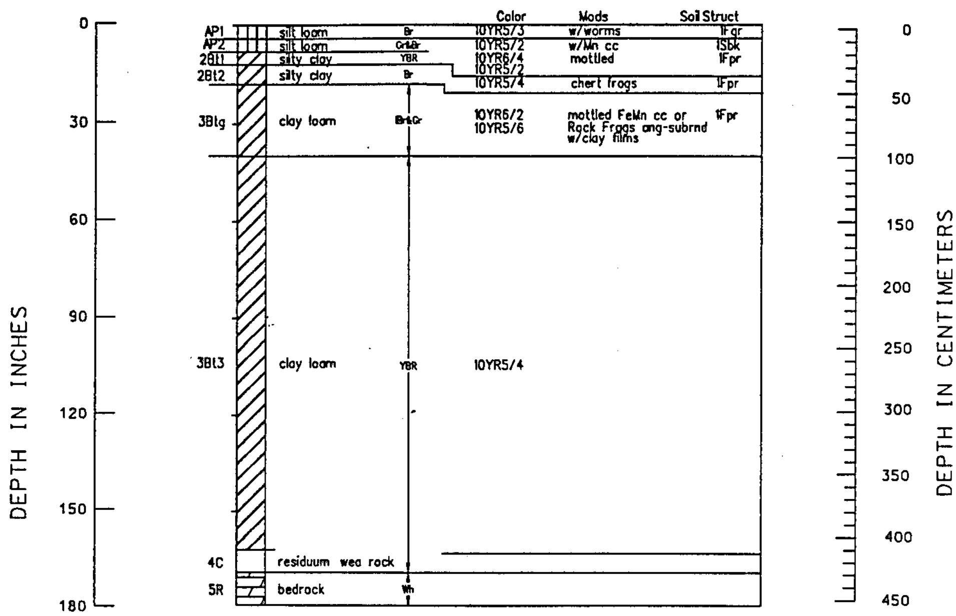


Upper Roubidoux 1

Fort Leonard Wood

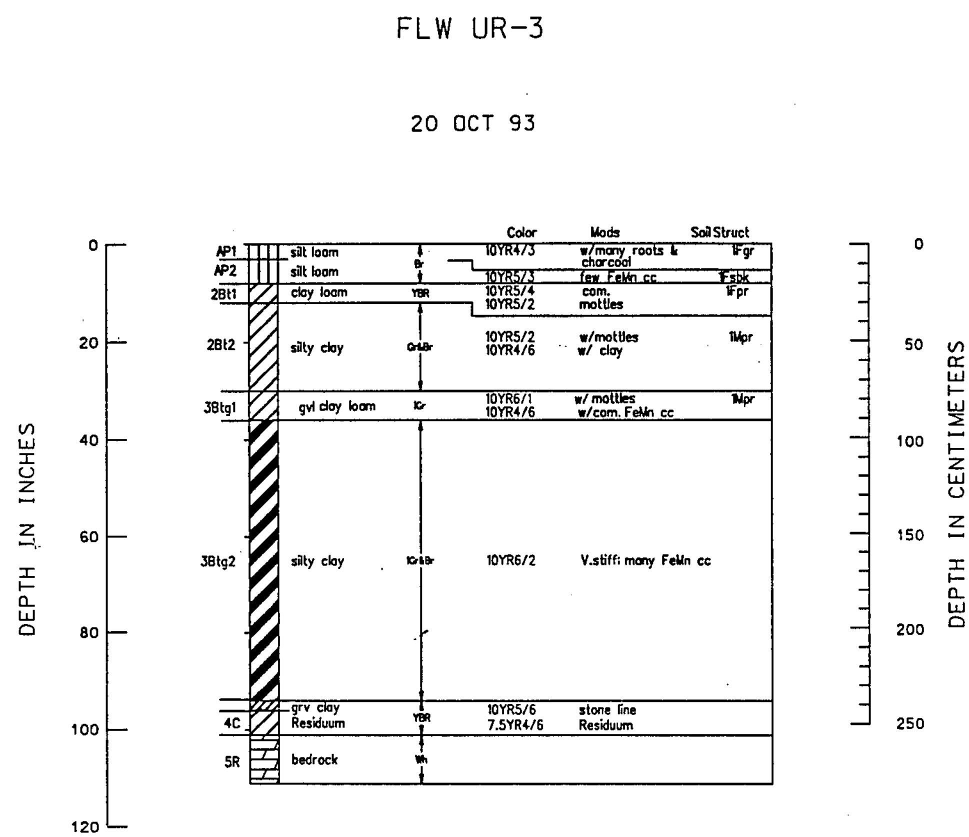
FLW UR-2

19 OCT 93



Upper Roubidoux 2

Fort Leonard Wood

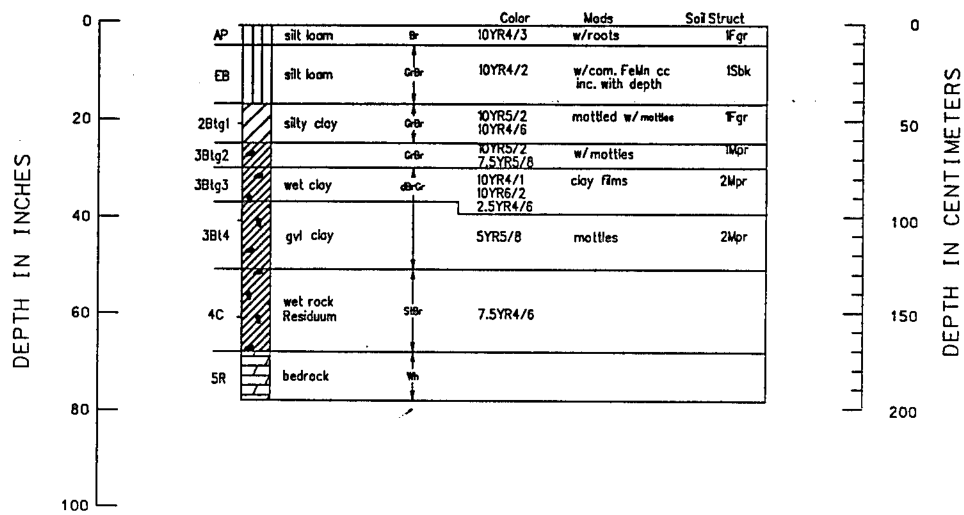


Upper Roubidoux 3

Fort Leonard Wood

FLW UR-4

20 OCT 93

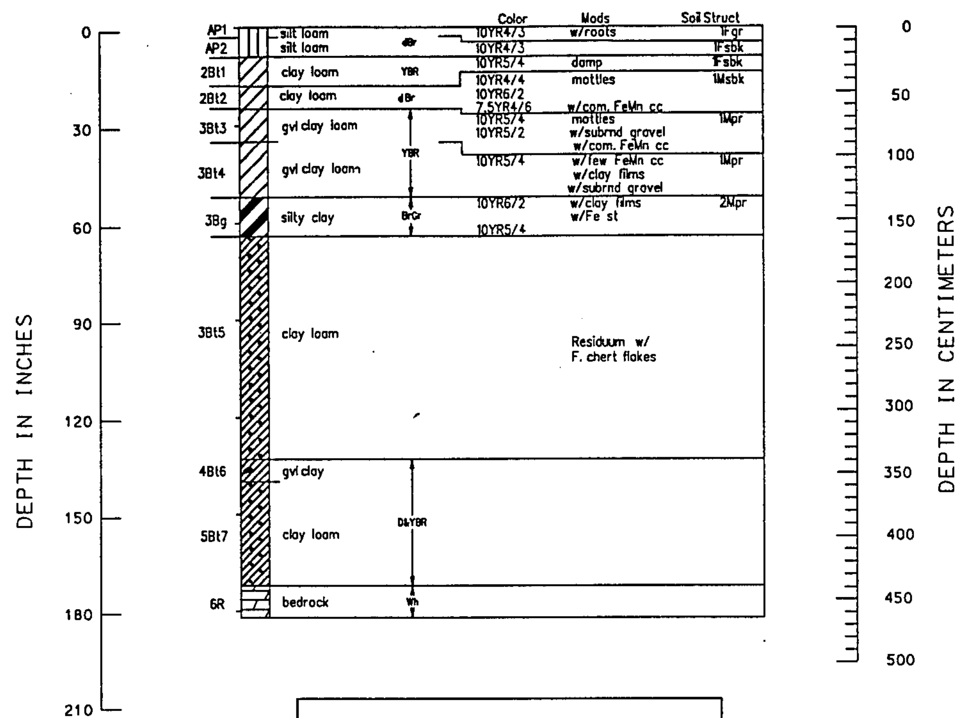


Upper Roubidoux 4

Fort Leonard Wood

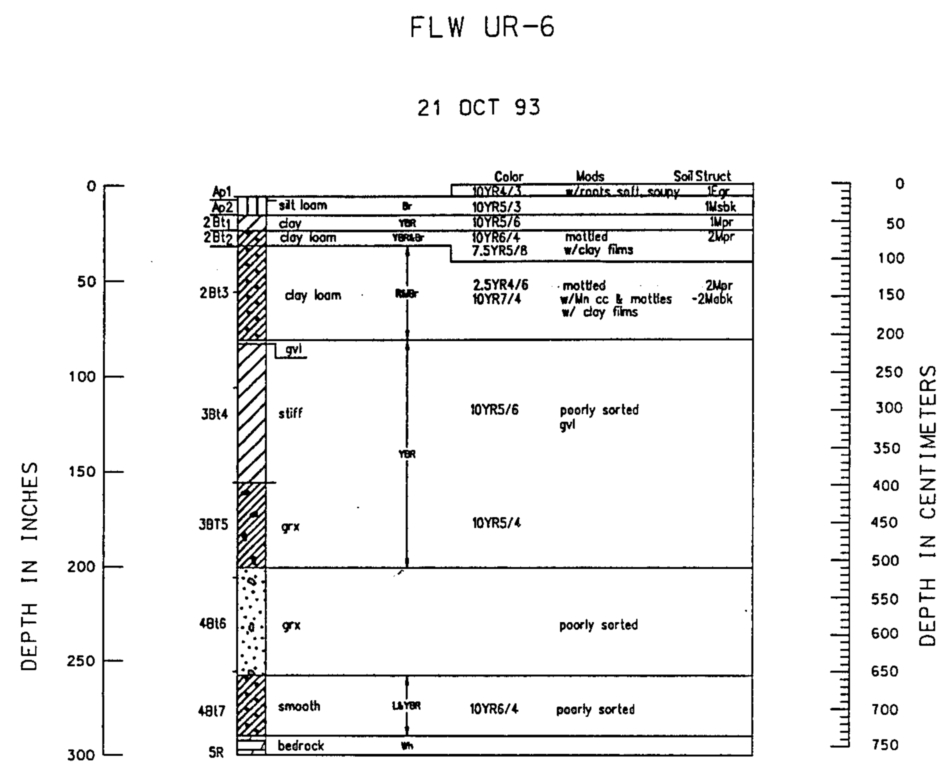
FLW UR-5

20 OCT 93



Upper Roubidoux 5

Fort Leonard Wood

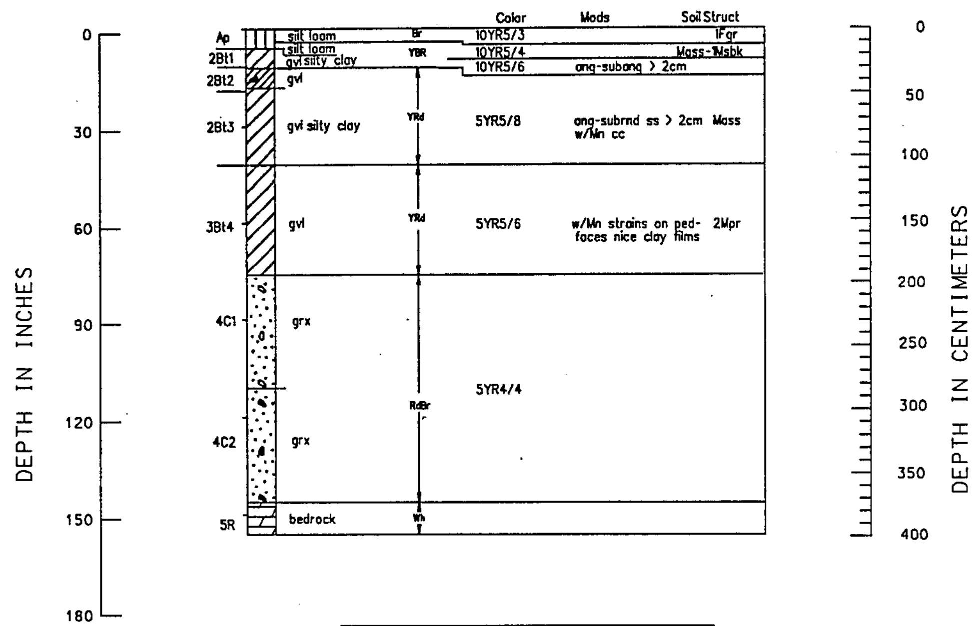


Upper Roubidoux 6

Fort Leonard Wood

UR-7

21 OCT 93

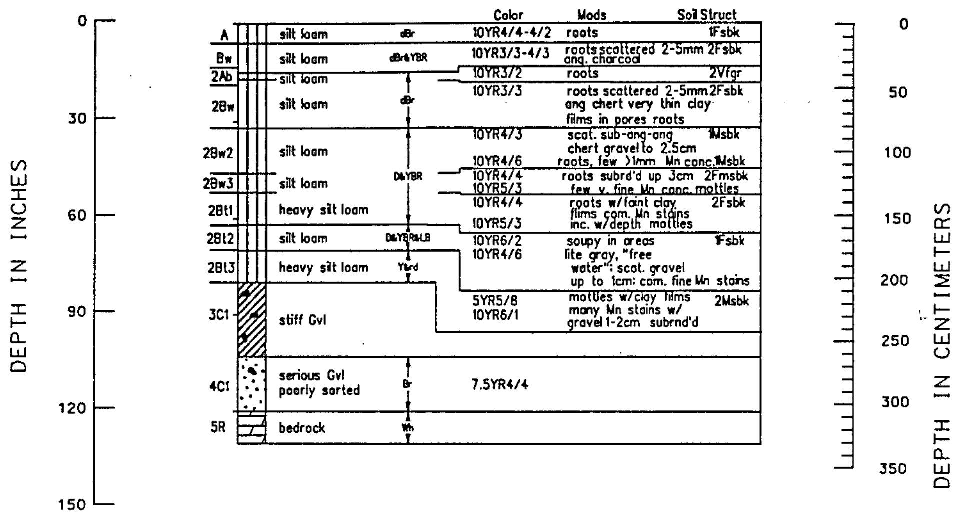


Upper Roubidoux 7

Fort Leonard Wood

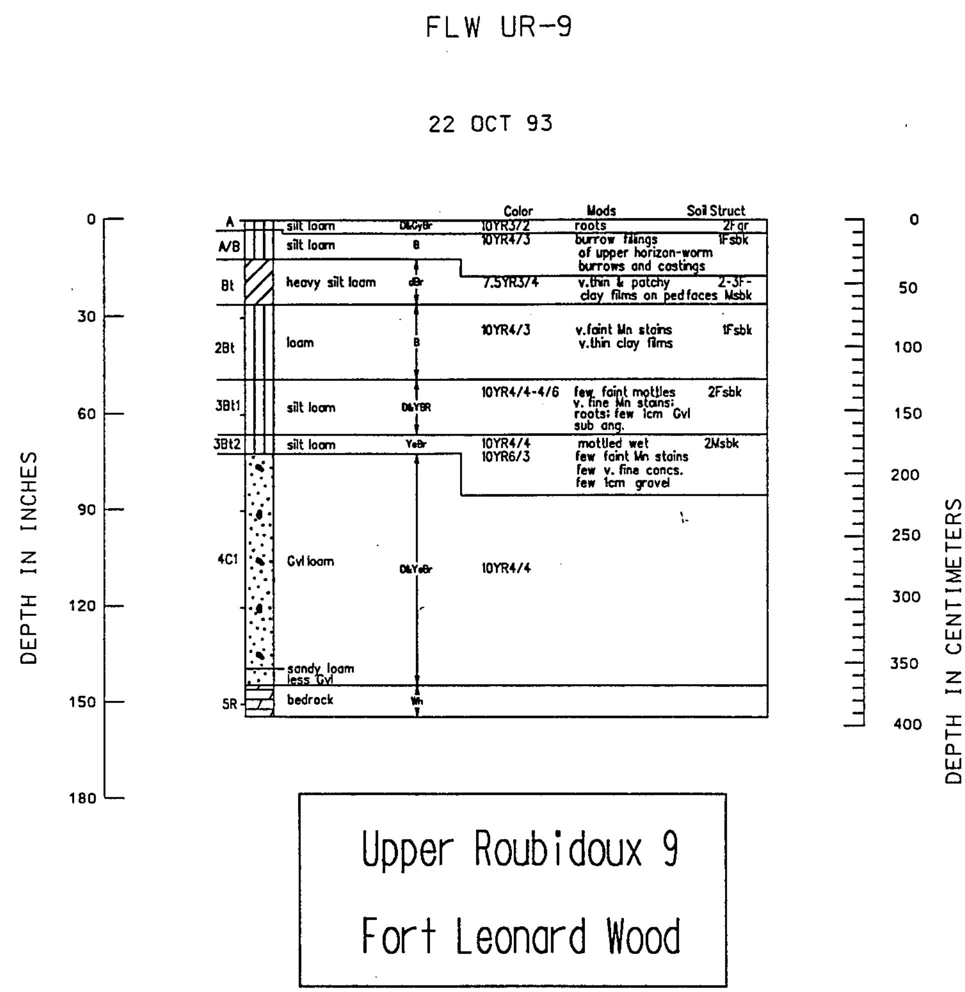
FLW UR-8

22 OCT 93



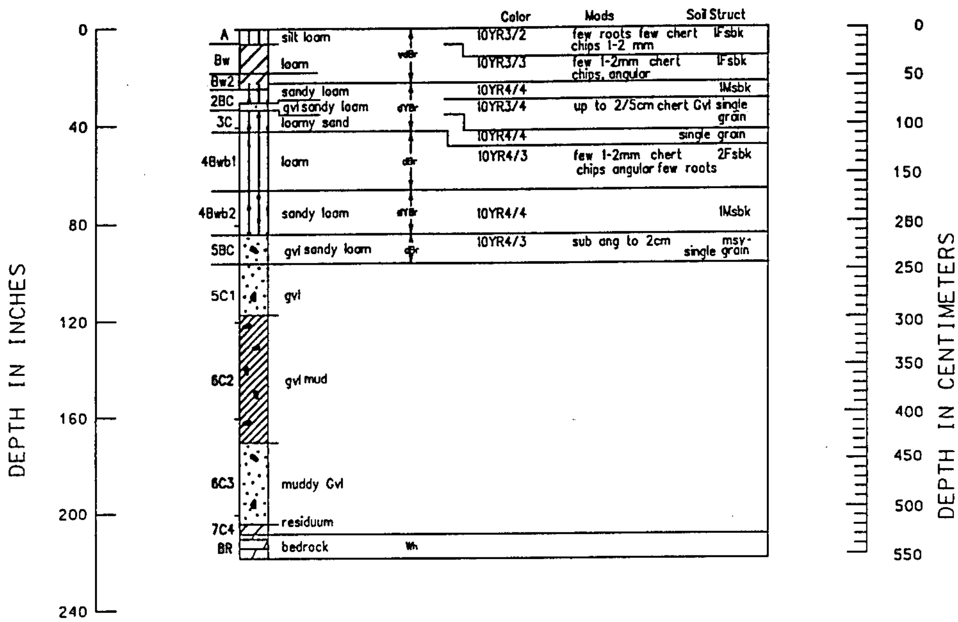
Upper Roubidoux 8

Fort Leonard Wood


FLW UR-9
22 OCT 93
DEPTH IN INCHES
0
30
60
90
120
150
180
Color
Mods
Soil Struct
A
silt loam
10YR3/2
roots
2Fgr
A/B
silt loam
10YR4/3
burrow fillings of upper horizon-worm burrows and castings
1Fsbk
Bt
heavy silt loam
7.5YR3/4
v.thin & patchy clay films on pedfaces
2-3F-Msbk
2Bt
loam
10YR4/3
v.faint Mn stains v.thin clay films
1Fsbk
3Bt1
silt loam
10YR4/4-4/6
few faint mottles v. fine Mn stains; roots; few 1cm Gvl sub ang.
2Fsbk
3Bt2
silt loam
10YR4/4
10YR6/3
mottled wet few faint Mn stains few v. fine concs. few 1cm gravel
2Msbk
4C1
Gvl loam
10YR4/4
sandy loam less Gvl
5R
bedrock
0
50
100
150
200
250
300
350
400
DEPTH IN CENTIMETERS
Upper Roubidoux 9
Fort Leonard Wood

FLW UR-11

22 OCT 93

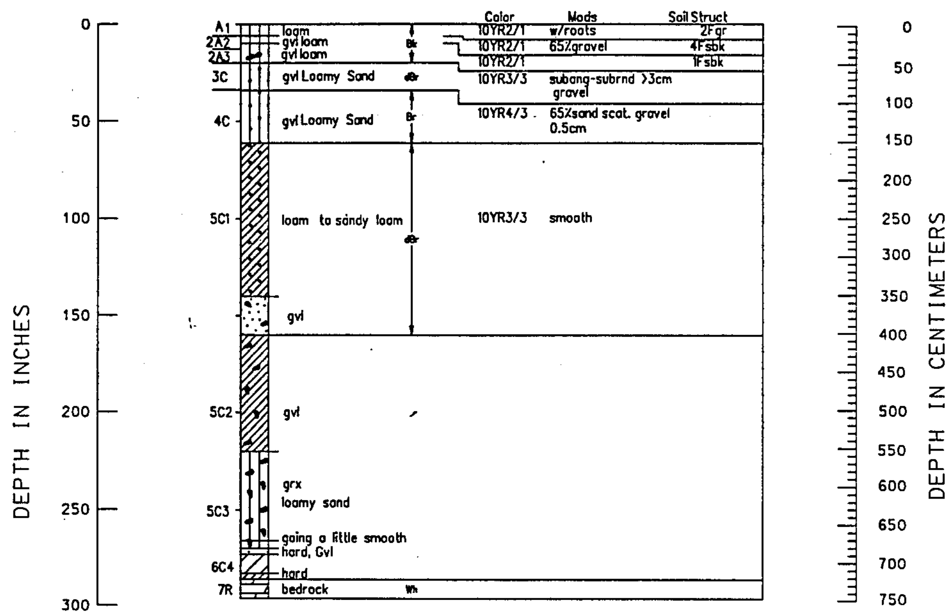


Upper Roubidoux 11

Fort Leonard Wood

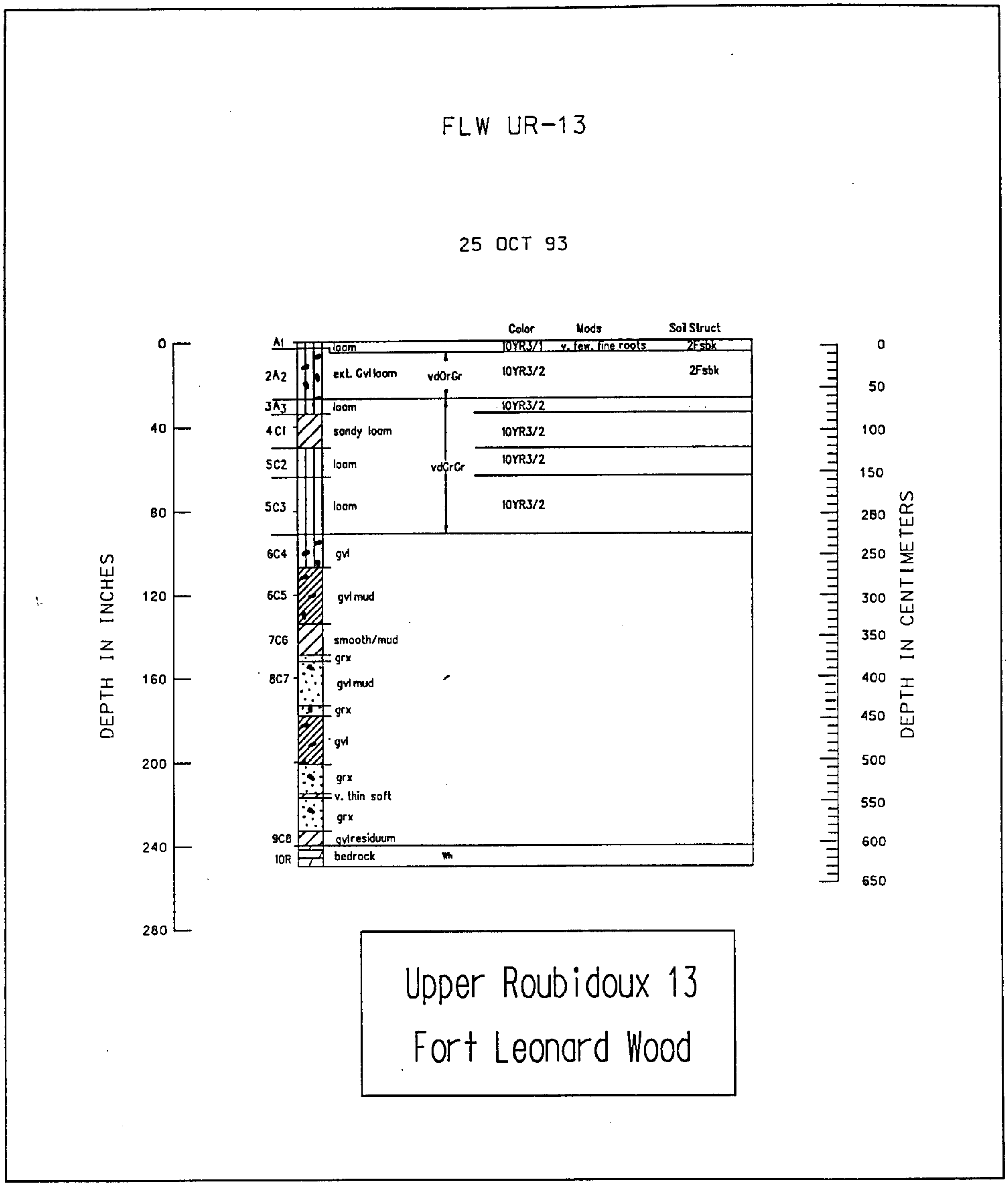
FLW UR-12

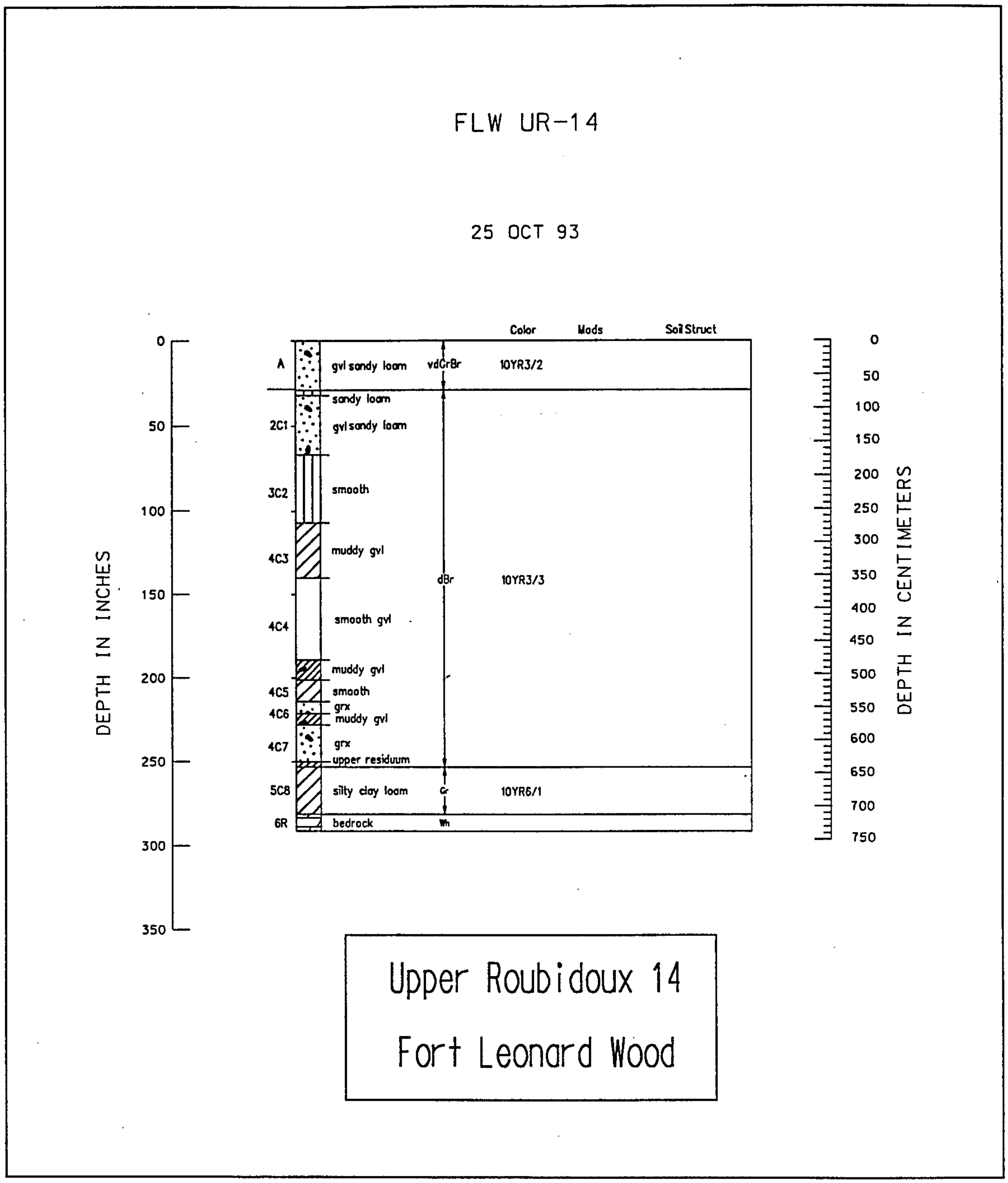
25 OCT 93



Upper Roubidoux 12

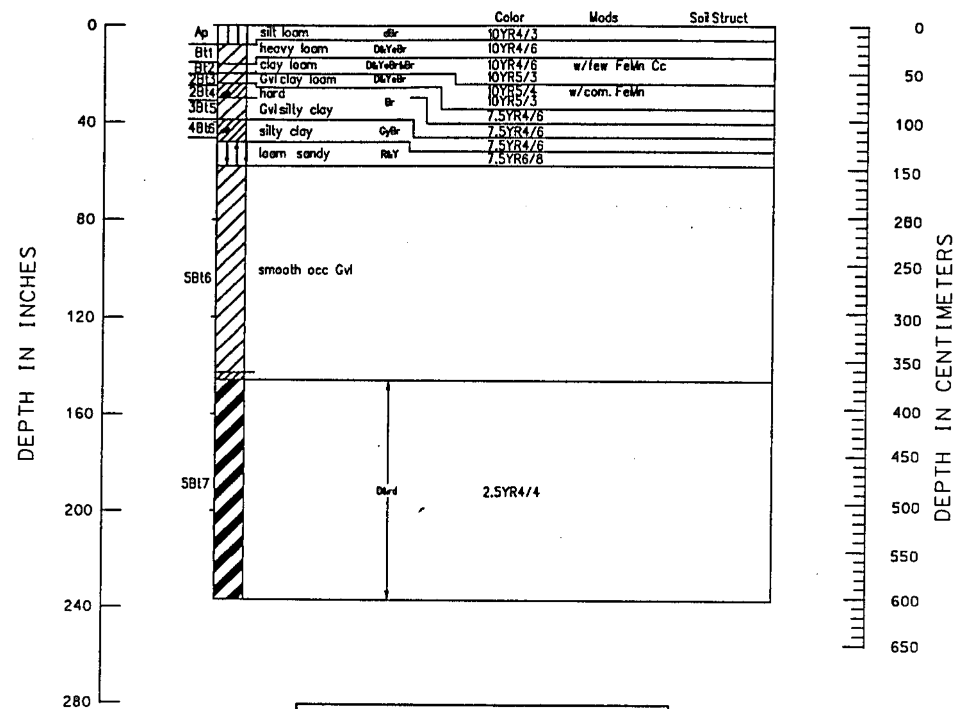
Fort Leonard Wood


FLW UR-13
25 OCT 93
Color
Mods
Soil Struct
A1
loam
10YR3/1
v. few, fine roots
2Fsbk
2A2
ext. Gvl loam
vdOrGr
10YR3/2
2Fsbk
3A3
loam
10YR3/2
4C1
sandy loam
10YR3/2
5C2
loam
vdGrCr
10YR3/2
5C3
loam
10YR3/2
6C4
gvl
6C5
gvl mud
7C6
smooth/mud
grx
8C7
gvl mud
grx
gvl
grx
v. thin soft
grx
9C8
gvlresiduum
10R
bedrock
DEPTH IN INCHES
0
40
80
120
160
200
240
280
DEPTH IN CENTIMETERS
0
50
100
150
200
250
300
350
400
450
500
550
600
650
Upper Roubidoux 13
Fort Leonard Wood


FLW UR-14
25 OCT 93
Color
Mods
Soil Struct
A
gvl sandy loam
vdGrBr
10YR3/2
sandy loam
2C1
gvl sandy loam
3C2
smooth
4C3
muddy gvl
dBr
10YR3/3
4C4
smooth gvl
muddy gvl
4C5
smooth
grx
4C6
muddy gvl
4C7
grx
upper residuum
5C8
silty clay loam
Gr
10YR6/1
6R
bedrock
Wh
DEPTH IN INCHES
0
50
100
150
200
250
300
350
DEPTH IN CENTIMETERS
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
Upper Roubidoux 14
Fort Leonard Wood

FLW UR-15

27 OCT 93

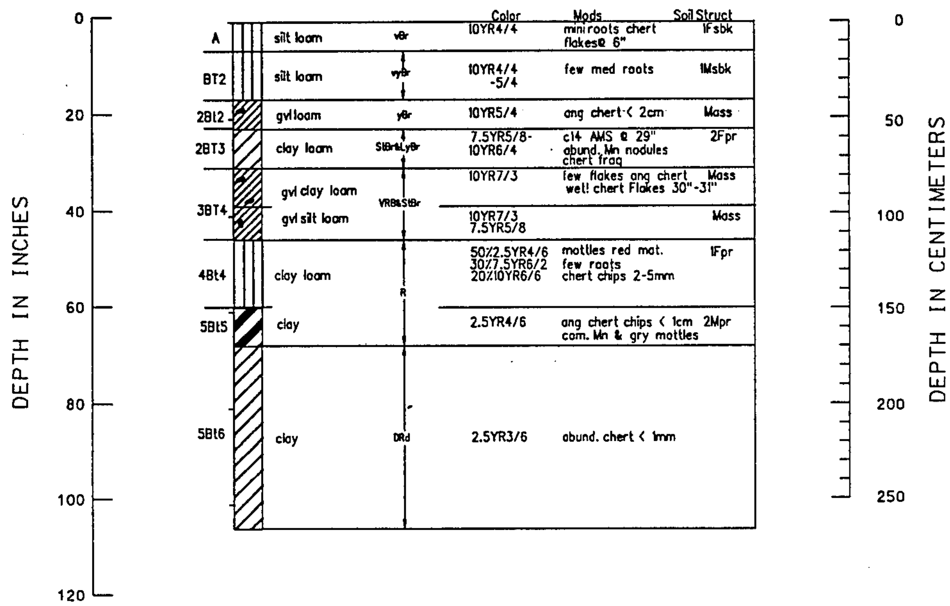


Upper Roubidoux 15

Fort Leonard Wood

FLW UR-16

25 OCT 93

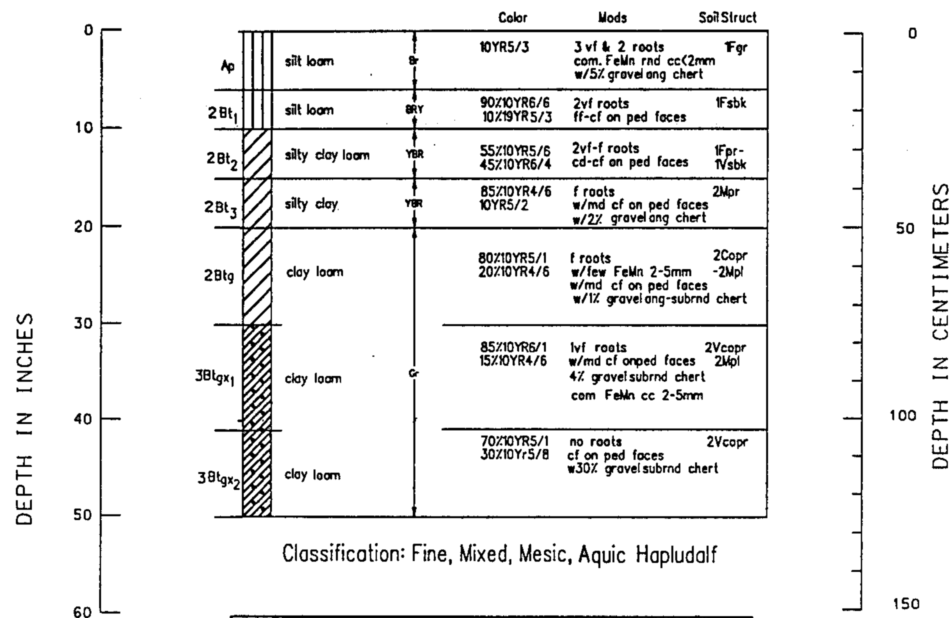


Upper Roubidoux 16

Fort Leonard Wood

UR–T1 @95′

22 OCT 93



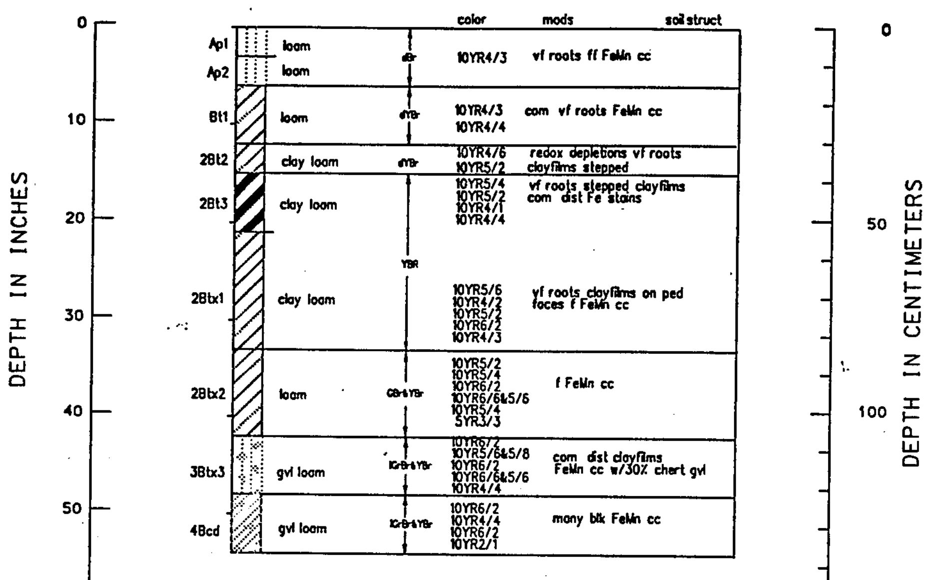
Classification: Fine, Mixed, Mesic, Aquic Hapludalf

Upper Roubidoux T-1 @ 95′

Fort Leonard Wood

UR-T2@10'

26 OCT 93



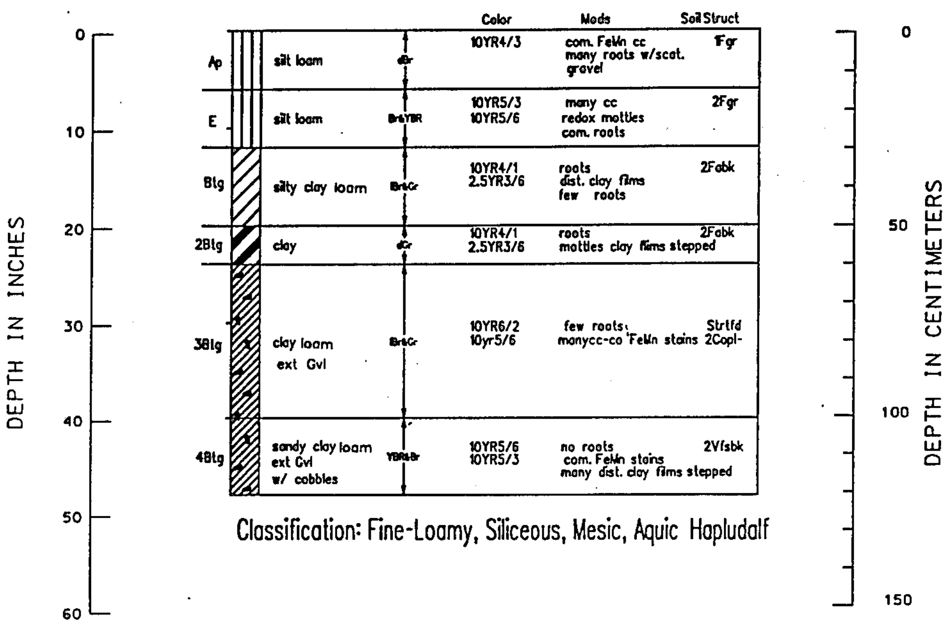
Classification: Fine-loamy, Siliceous, Mesic, Aqualtic Hapludalt

Upper Roubidoux T2 @10'

Fort Leonard Wood

UR-T2 @50'

23 OCT 93



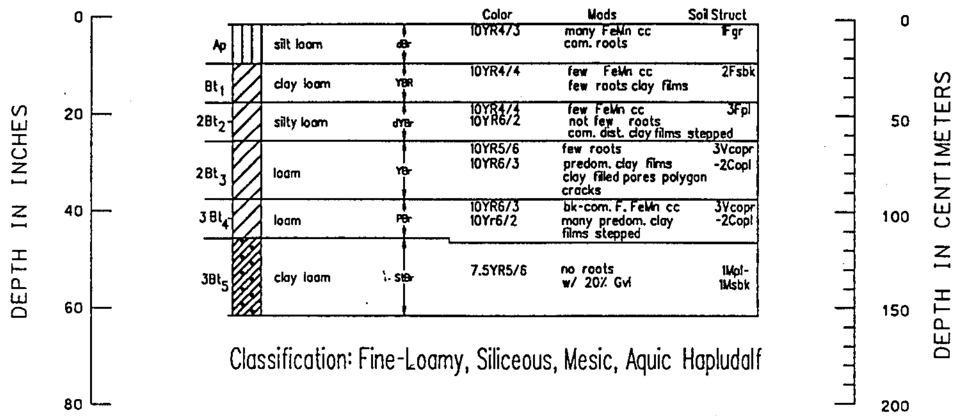
Classification: Fine-Loamy, Siliceous, Mesic, Aquic Hapludalf

Upper Roubidoux T-2 @ 50'

Fort Leonard Wood

UR-T2 @140'

22 OCT 93

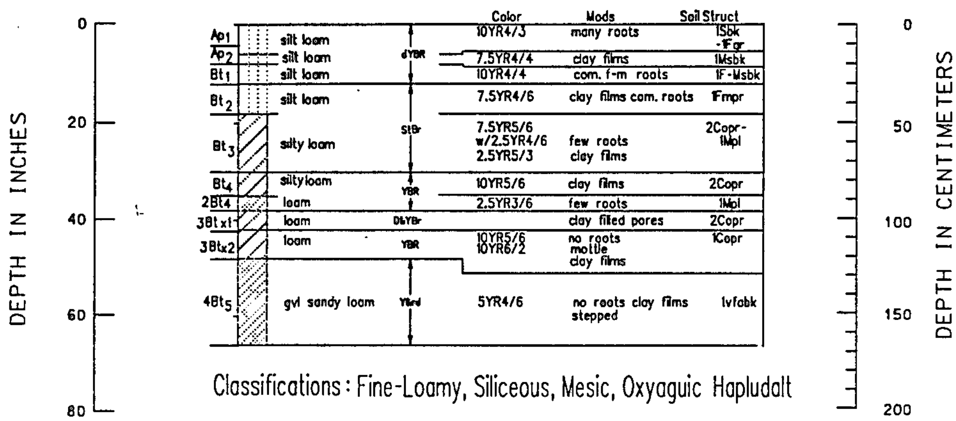


Upper Roubidoux T-2 @ 140'

Fort Leonard Wood

UR-T3 @80'

25 OCT 93

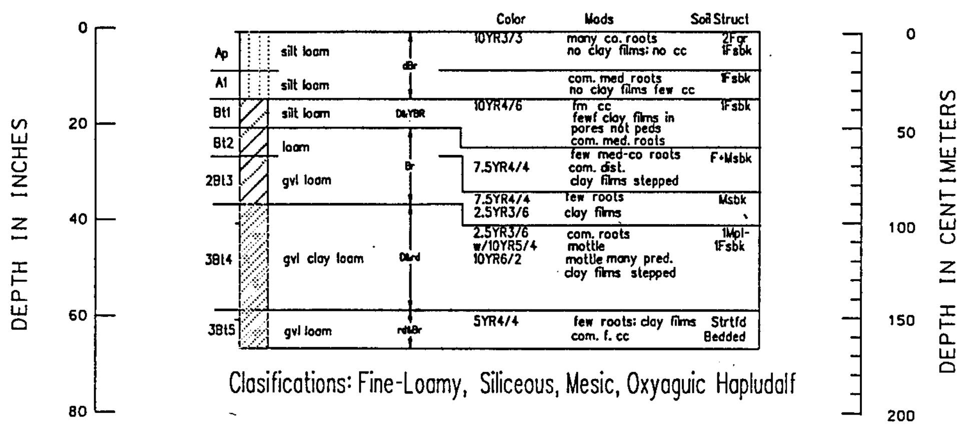


Upper Roubidoux T-3 @ 80'

Fort Leonard Wood

UR-T3 @110'

25 OCT 93

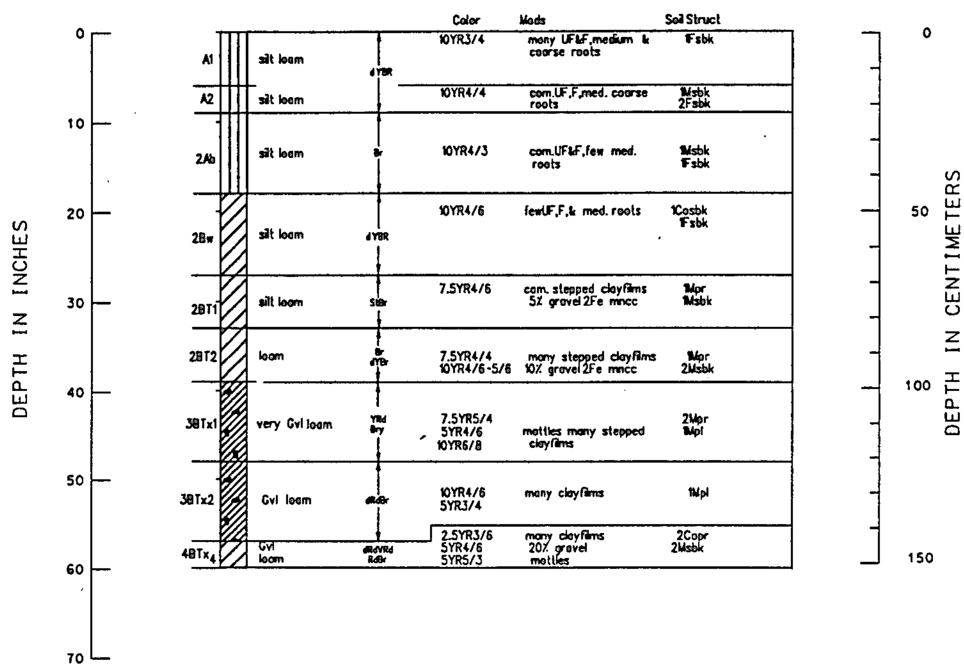


Clasifications: Fine-Loamy, Siliceous, Mesic, Oxyaguic Hapludalf

Upper Roubidoux T-3 @ 110' Fort Leonard Wood

UR-T3@130'

27 OCT 93

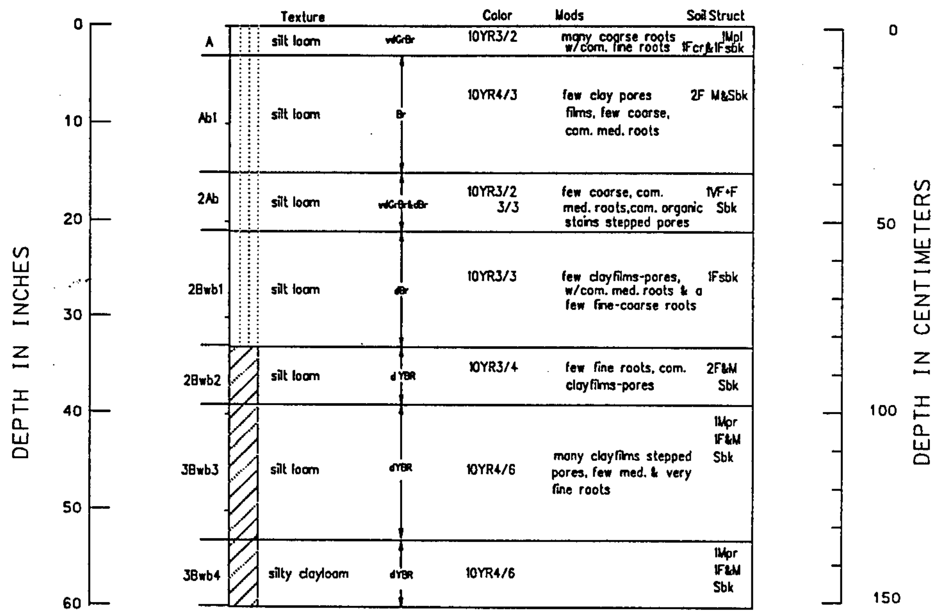


Upper Roubidoux Trench 1 @130'

Fort Leonard Wood

UR-T3@170

27 OCT 93



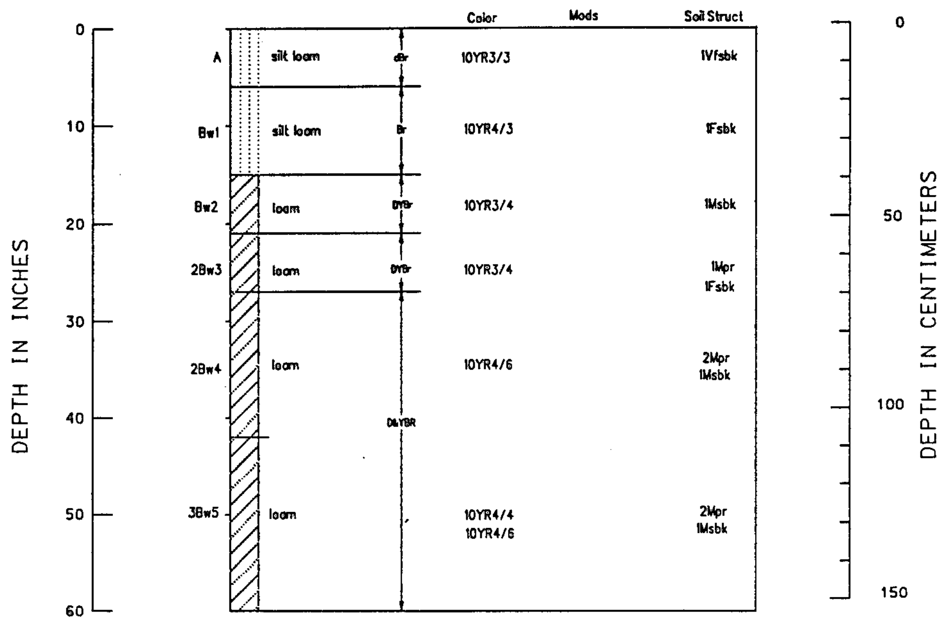
Classification: Fine-Silty, Siliceous, Mesic, Dystric, Fluventic Eutrocrept

Upper Roubidoux T-3@170'

Fort Leonard Wood

UR-T4@5'

28 OCT 93



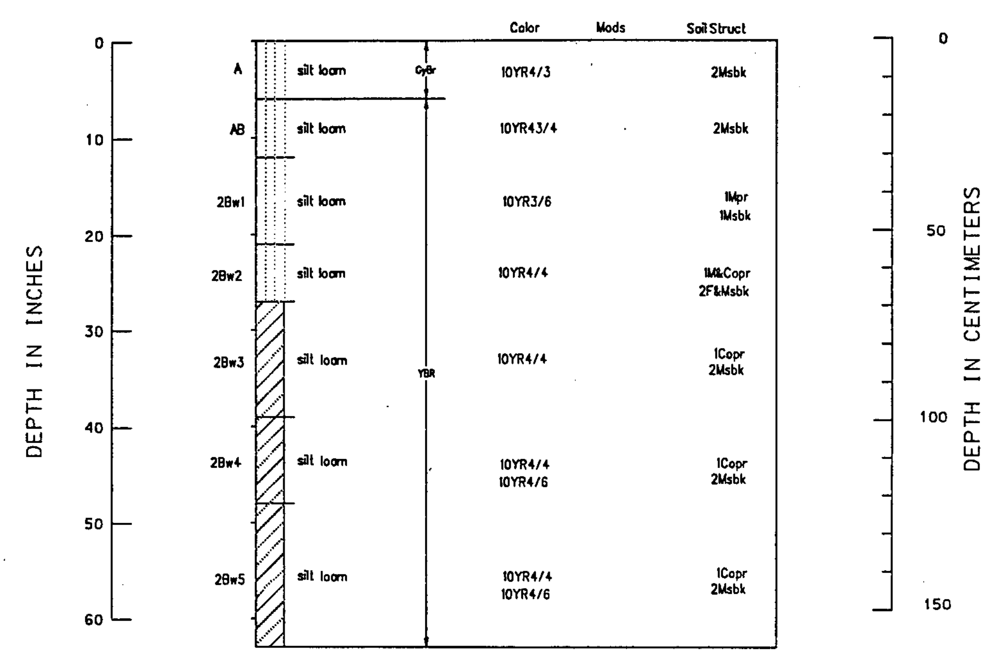
Classification: Fine-Loamy, Siliceous, Mesic, Fluventic Eutrochrept

Upper Roubidoux T-4@5'

Fort Leonard Wood

UR-T4@30

27 OCT 93



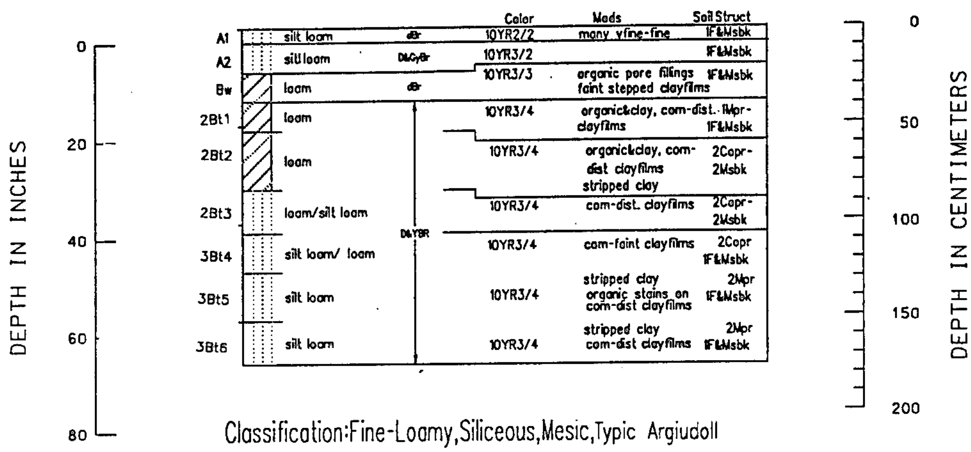
Classification: Fine-Loamy, Siliceous, Mesic Fluventic Eutrochrept

Upper Roubidoux T-4@30'

Fort Leonard Wood

UR-T4@80'

27 OCT 93



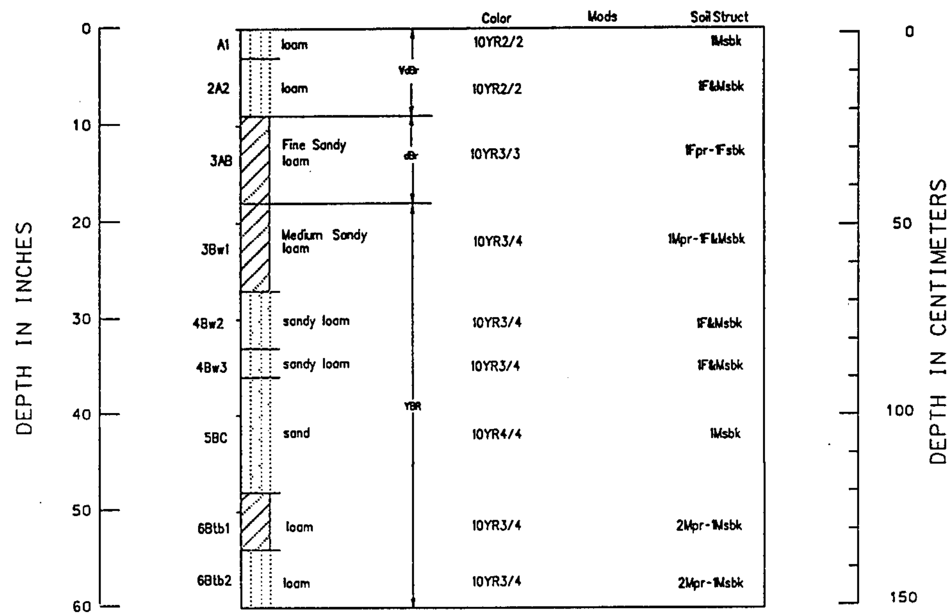
Classification:Fine-Loamy,Siliceous,Mesic,Typic Argiudoll

Upper Roubidoux T-4 @ 80

Fort Leonard Wood

UR-T4@125

27 OCT 93



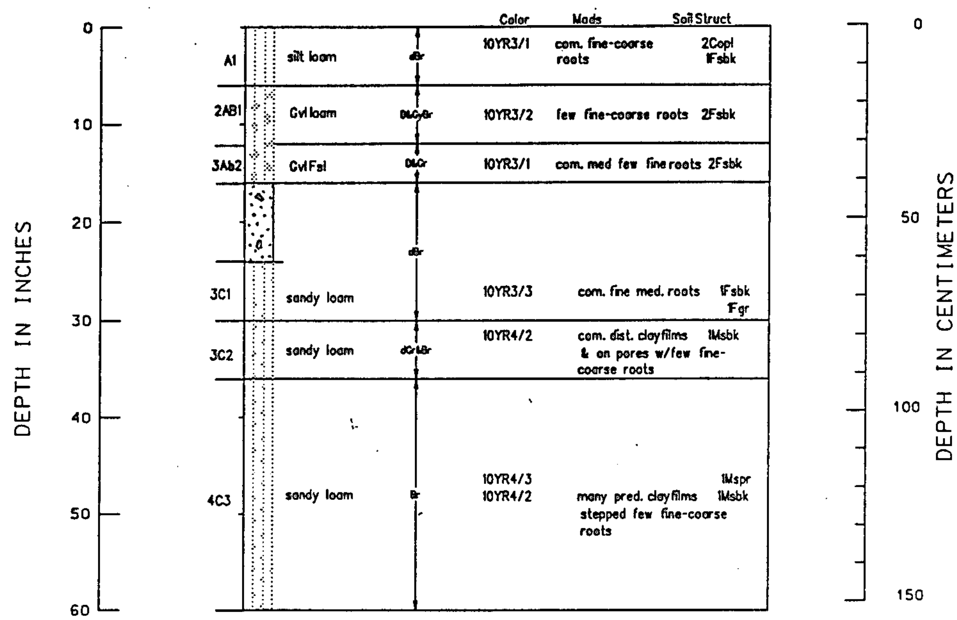
Classification: Coarse-loamy, Siliceous, Mesic, Fluventic Hapludoll:

Upper Roubidoux T-4 @ 125

Fort Leonard Wood

UR-T5@10

23 OCT 93



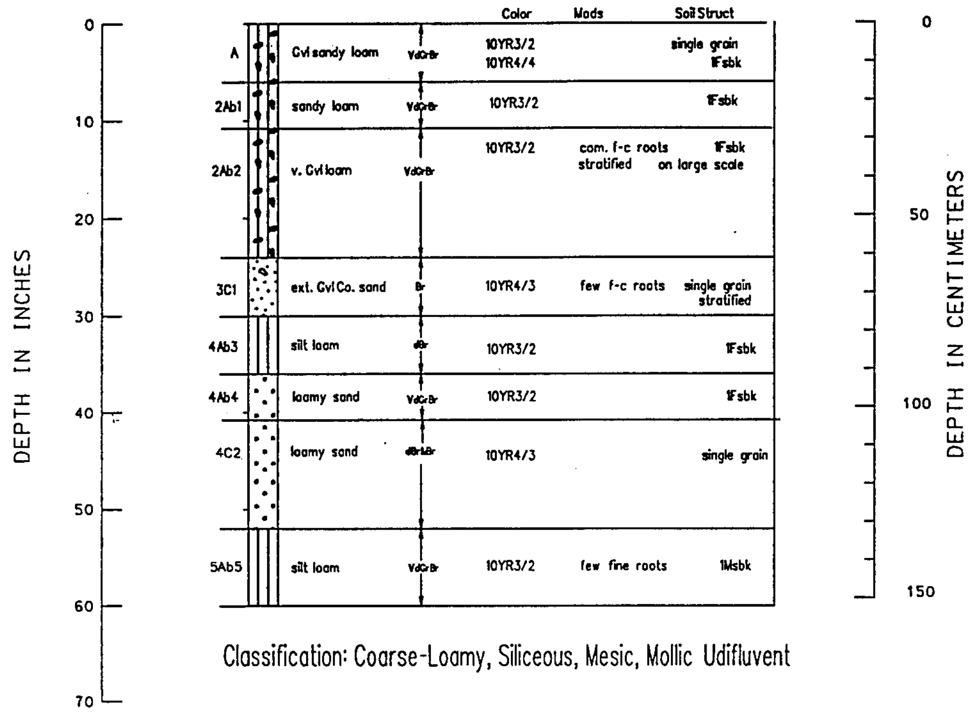
Classification: Loamy-Skeletal, Siliceous, Mesic, Cumulic Hapludoll

Upper Roubidoux T-5@10'

Fort Leonard Wood

UR-T5@80

25 OCT 93



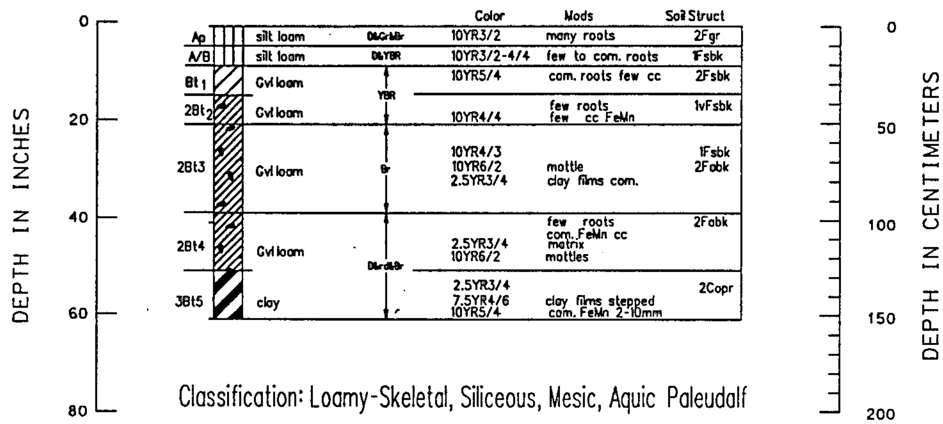
Classification: Coarse-Loamy, Siliceous, Mesic, Mollic Udifluvent

Upper Roubidoux T-5@80'

Fort Leonard Wood

UR-T6

27 OCT 93



Upper Roubidoux T-6

Fort Leonard Wood

Appendix B
Soil Laboratory Data

3-22-95

Paul Koenig
MU SNR Soils
144 Mumford Hall
Columbia, MO. 65211

Paul Albertson
GG YG
USA E WES
3909 Halls Ferry Rd.
Vicksburg, Miss. 39180

Mr. Albertson,

At the request of Dennis Meinert, soil scientist working at the Houston Missouri soil survey office, I've enclosed all data from the Fort Leonard Wood project. Ive included a paper copy of the data including the field descriptions I received, as well as a computer disk copy in ASCII format. There are 39 files on the floppy disk, and by comparing the data from the paper copy with the disk data you'll be able to identify the field headings. I've included the percent gravel as the last field in each sample record. If you have questions feel free to contact me at 314-882-3705.

Sincerely,
Paul Koenig

Paul O. Koenig

cc: Dennis Meinert

BOUNDARY: Horizon lower boundaries are described as to:

(1) Distinctness:

abrupt (<1" thick)	...a	gradual (2 1/2" -5")	...g
clear (1" -2 1/2")	...c	diffuse (>5" thick)	...d

(2) Topography of boundary:

smooth	(nearly a plane)	...s
wavy	(pockets with width>depth)	...w
irregular	(pockets with depth>width)	...i
broken	(discontinuous)	...b

Thus an abrupt, irregular boundary is noted as ai

TEXTURE:

gravel	...g	gravelly sandy loam	...gsl
very coarse sand	...vcos	loam	...l
coarse sand	...cos	gravelly loam	...gl
sand	...s	stony loam	...stl
fine sand	...fs	silt	...si
very fine sand	...vfs	silt loam	...sil
loamy coarse sand	...lcos	clay loam	...cl
loamy sand	...ls	silty clay loam	...sicl
loamy fine sand	...lfs	sandy clay loam	...scl
sandy loam	...sl	stony clay loam	...stcl
fine sandy loam	...fsl	silty clay	...sic
very fine sandy loam	..vfsl	clay	...c

STRUCTURE:

(1) GRADE

structureless...	0	(No observable aggregation or no orderly arrangement of natural lines of weakness).
weak	... 1	(Poorly formed indistinct peds, barely observable in place).
moderate	... 2	(Well-formed distinct peds, moderately durable and evident, but not distinct in undistrubed soil).
strong	... 3	(Durable peds that are quite evident in undisplaced soil, adhere weakly to one another,- withstand displacement, and become separated when soil is disturbed).

(2) SIZE: (See accompanying table for size limits).

very fine	... vf	medium	... m
fine	... f	coarse	... c
		very coarse	... vc

(Read "thin" and "thick" for platy instead of "fine" and "coarse").

(3) FORM OF TYPE: (See accompanying table for definitions.)

platy	... pl	granular	... gr
prismatic	... pr	crumb	... cr
columnar	... cpr	(single grain	... sg)
blocky	... bk	(massive	... m)

angular blocky ... abk
subangular blocky ... sbk

Thus weak medium block structure is noted 1mbk, moderate very thin platy as 2vfpl, etc.

CONSISTENCE: (The notation of consistence varies with moisture content (See pp. 231 to 234).

(1) Wet soil:

nonsticky ...wso
slightly sticky ..wss
sticky ...ws
very sticky ...wvs
nonplastic ...wpo
slightly plastic..wps
plastic ...sp
very plastic ...wvp

(2) Moist soil:

loose ...ml
very friable ...mvfr
friable ...mfr
firm ...mfi
very firm ...mvfi
extremely firm ...mefi

(3) Dry soil:

loose ...dl
soft ...ds
slightly hard ...dsh
hard ...dh
very hard ...dvh
extremely hard ...deh

(4) Cementation:

weakly cemented ..cw
strongly cemented ..cs
indurated ..ci

REACTION: Use pH figures.

Indicate effervescence with HCl as:

slight ..e
strong ..es
violent ..ev

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of <2mm											
HHT120	8-11.4	3-4.5	--	12.1	67.8	20.1	39.3	28.4	2.4	7.6	3.9	3.4	2.9	17.7	SIL
HHT120	11.4-23	4.5-9	--	11.9	71.5	16.6	46.1	25.4	2.4	6.5	3.2	2.7	1.7	14.2	SIL
HHT120	23-28	9-11	--	13.6	71.2	15.2	43.2	28.0	2.4	6.7	3.1	2.2	0.9	12.8	SIL
HHT120	28-36	11-14	--	23.8	64.0	12.2	42.8	21.2	2.0	5.8	2.5	1.4	0.5	10.2	SIL
HHT120	36-43	14-17	--	35.6	53.6	10.8	33.9	19.7	1.9	5.5	2.1	0.9	0.5	8.9	SICL
HHT120	43-51	17-20	--	49.3	42.7	8.0	26.6	16.1	1.4	4.0	1.6	0.5	0.5	6.6	SIC
HHT120	51-58	20-23	--	53.7	38.8	7.4	22.2	16.6	1.4	3.8	1.4	0.5	0.3	6.0	C
HHT120	58-66	23-26	--	58.5	35.4	6.1	20.4	15.0	1.2	3.3	1.2	0.3	0.2	4.9	C
HHT120	66-74	26-29	--	50.6	41.8	7.7	24.3	17.5	1.4	4.0	1.4	0.5	0.3	6.3	SIC
HHT120	74-86	29-34	--	39.2	49.7	11.1	31.3	18.3	2.1	5.9	2.1	0.7	0.2	9.0	SICL
HHT120	86-99	34-39	--	39.0	50.1	10.9	29.8	20.3	2.2	5.7	2.1	0.7	0.3	8.7	SICL
HHT120	99-112	39-44	--	40.7	49.3	10.0	29.4	19.9	1.9	5.3	1.9	0.6	0.3	8.1	SIC
HHT120	112-124	44-49	--	43.5	47.0	9.5	28.3	18.7	1.9	5.0	1.8	0.6	0.2	7.6	SIC
HHT120	124-137	49-54	--	40.9	50.3	8.8	31.4	18.9	1.8	4.5	1.5	0.6	0.5	7.0	SIC
HHT120	137-150	54-59	--	38.4	48.8	12.8	28.3	20.5	2.5	6.3	2.2	1.1	0.7	10.3	SICL
HHT120	150-163	59-64	--	41.5	48.3	10.3	29.2	19.1	2.1	4.7	1.5	1.0	0.9	8.2	SIC
HHT120	163-175	64-69	--	32.6	53.6	13.8	31.7	21.9	2.6	7.0	1.9	1.0	1.3	11.2	SICL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +AL	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
HHT120	3.4	2.4	.1	.2	6.1	4.3	.1	10.4	8.8	6.2	2	59	69	1.0	6.0	6.3
HHT120	2.4	2.0	.1	.1	4.6	4.6	0.0	9.2	7.4	4.6	0	50	62	0.7	5.9	6.6
HHT120	1.2	1.6	.1	.1	3.0	5.9	.5	8.8	7.4	3.5	14	34	41	0.5	4.8	5.6
HHT120	1.0	2.4	.1	.1	3.6	9.5	4.8	13.1	11.6	8.3	57	27	31	0.2	4.3	5.2
HHT120	1.5	4.0	.3	.1	5.9	14.0	8.2	19.9	18.2	14.1	58	30	32	0.3	4.2	5.0
HHT120	1.7	7.1	.5	.2	9.5	19.4	11.9	28.9	26.1	21.4	56	33	36	0.3	4.2	4.9
HHT120	1.9	9.1	.6	.3	11.9	21.2	12.2	33.1	29.7	24.1	51	36	40	0.3	4.2	4.9
HHT120	1.7	11.0	.8	.4	13.9	23.0	11.0	36.9	31.9	24.9	44	38	44	0.3	4.2	4.8
HHT120	1.4	10.2	.7	.2	12.5	18.8	10.2	31.3	27.3	22.7	45	40	46	0.3	4.2	5.0
HHT120	1.0	8.8	.6	.2	10.7	11.9	5.0	22.6	20.4	15.7	32	47	52	0.2	4.4	5.1
HHT120	1.2	11.4	.8	.1	13.5	7.4	.9	20.9	19.4	14.4	6	65	70	0.1	5.0	5.7
HHT120	1.5	13.9	1.0	.1	16.5	4.4	0.0	20.9	20.3	16.5	0	79	81	0.2	5.9	6.5
HHT120	1.9	14.9	1.2	.1	18.1	3.9	0.0	22.0	22.2	18.1	0	82	82	0.1	6.6	7.1
HHT120	1.7	15.9	1.3	.2	19.1	2.6	0.0	21.7	21.3	19.1	0	88	90	0.1	6.8	7.4
HHT120	1.7	15.4	1.3	.2	18.6	2.5	0.0	21.1	21.3	18.6	0	88	87	0.1	7.1	7.6
HHT120	2.0	17.1	1.4	.3	20.8	3.0	0.0	23.8	23.0	20.8	0	87	90	0.1	7.1	7.7
HHT120	1.4	13.5	1.1	.2	16.2	2.1	0.0	18.3	17.9	16.2	0	89	91	0.1	7.2	7.8

Ft. Leonard Wood sample data 12-20-93 MISSOURI SOIL CHARACTERIZATION LABORATORY

MFLW2

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of <2mm											
HHT170	46-53	18-21	--	15.6	66.6	17.8	42.4	24.2	3.2	9.0	3.2	1.7	0.8	14.6	SIL
HHT170	53-58	21-23	--	23.1	53.6	23.3	32.2	21.4	2.6	9.4	4.9	3.4	3.1	20.7	SIL
HHT170	61-69	24-27	--	19.6	42.0	38.4	22.9	19.1	4.0	13.4	6.9	5.6	8.6	34.4	L
HHT170	76-84	30-33	--	52.8	33.4	13.7	14.5	18.9	2.7	7.6	2.2	1.0	0.3	11.0	C
HHT170	91-99	36-39	--	28.6	48.0	23.4	25.1	22.9	4.6	12.7	3.5	1.9	0.7	18.8	CL
HHT170	114-122	45-48	--	35.2	43.9	20.9	24.6	19.3	3.0	9.9	4.3	2.7	1.0	17.9	CL
HHT325	0-6.4	0-2.5	--	1.7	3.5	94.7	2.5	1.0	1.9	61.3	28.1	2.9	0.5	92.8	FS
HHT325	6.4-10	2.5-4	--	4.0	6.0	90.0	1.9	4.1	2.9	44.3	34.2	6.8	1.7	87.1	S
HHT325	13-23	5-9	--	3.0	3.9	93.1	0.6	3.3	1.9	44.8	37.0	7.8	1.5	91.2	S
HHT325	24-28	9.5-11	--	0.7	1.9	97.4	1.8	0.2	1.0	41.1	48.0	6.3	1.0	96.4	S
HHT325	30-38	12-15	--	0.8	2.4	96.9	1.2	1.1	0.8	43.5	46.8	5.2	0.6	96.1	S
HHT325	53-61	21-24	--	3.2	2.0	94.8	0.3	1.7	1.2	46.6	41.7	4.5	0.9	93.6	S
HHT325	71-86	28-34	--	2.3	4.5	93.2	3.0	1.5	1.5	45.3	41.0	4.7	0.7	91.7	S
HHT325	102-107	40-42	--	2.0	3.9	94.1	2.5	1.4	1.6	41.2	39.0	9.1	3.2	92.5	S
HHT325	107-114	42-45	--	8.6	20.3	71.1	9.7	10.6	5.4	47.8	15.6	2.0	0.4	65.7	FSL
HHT325	127-135	50-53	--	7.1	13.4	79.5	5.6	7.7	5.1	49.0	19.8	4.0	1.6	74.4	LS
HHT325	135-147	53-58	--	7.8	13.1	79.1	4.9	8.2	5.0	50.8	19.4	3.4	0.5	74.1	LFS
HHT325	147-160	58-63	--	5.3	7.0	87.8	1.8	5.2	2.8	44.3	30.3	8.9	1.6	85.0	S
HHT325	160-165	63-65	--	1.8	2.5	95.7	2.2	0.2	1.1	19.3	22.8	16.6	36.0	94.6	COS
HHT325	165-169	65-	--	3.4	2.0	94.6	0.3	1.7	1.0	43.7	38.8	8.4	2.8	93.6	S
HHT325	169-173	-68	--	7.7	14.6	77.7	6.6	8.1	4.8	46.2	19.8	5.6	1.2	72.9	FSL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	NH4 OAc	BASES +AL	Al SAT	BASE SAT SUM	NH4 OAc	ORG C	pH CaCl2 .01M	H2O
	meq/100 g										%					
HHT170	1.4	1.6	.1	.1	3.2	6.6	.8	9.8	7.6	4.0	20	33	42	0.4	4.6	5.4
HHT170	2.2	2.4	.2	.1	4.9	7.6	2.2	12.5	11.3	7.1	31	39	43	0.2	4.5	5.3
HHT170	1.2	1.6	.1	.1	3.0	8.8	2.2	11.8	10.4	5.2	42	25	29	0.1	4.5	5.4
HHT170	4.4	9.2	.4	.2	14.2	16.3	5.9	30.5	27.0	20.1	29	47	53	0.3	4.4	5.0
HHT170	2.4	5.6	.2	.1	8.3	5.3	.3	13.6	13.1	8.6	3	61	63	0.1	5.1	5.8
HHT170	4.1	8.0	.3	.1	12.5	4.0	0.0	16.5	15.8	12.5	0	76	79	0.1	6.0	6.5
HHT325	2.5	1.5	0.0	.1	4.1	.8	--	4.9	2.8	--	--	84	100	0.7	6.5	7.2
HHT325	2.9	1.6	TR	TR	4.6	1.7	--	6.3	3.1	--	--	73	100	0.5	6.6	7.2
HHT325	2.6	1.9	TR	TR	4.6	.7	--	5.3	1.6	--	--	87	100	0.4	6.8	7.6
HHT325	1.2	.8	0.0	TR	2.0	.7	--	2.7	1.4	--	--	74	100	0.2	6.7	7.6
HHT325	1.0	.8	0.0	TR	1.8	1.0	--	2.8	1.5	--	--	64	100	0.1	6.6	7.5
HHT325	1.2	.8	0.0	TR	2.0	1.7	--	3.7	1.6	--	--	54	100	0.2	6.6	7.6
HHT325	.9	.8	0.0	TR	1.7	.5	--	2.2	1.6	--	--	77	100	0.1	6.6	7.6
HHT325	.7	.4	0.0	TR	1.1	2.0	--	3.1	1.6	--	--	35	69	0.1	6.1	7.1
HHT325	3.3	1.6	0.0	.1	5.0	1.0	--	6.0	5.8	--	--	83	86	0.4	6.6	7.4
HHT325	2.4	1.2	TR	TR	3.7	1.4	--	5.1	4.8	--	--	73	77	0.3	6.5	7.3
HHT325	2.7	1.2	TR	.1	4.0	2.0	--	6.0	4.5	--	--	67	89	0.3	6.4	7.3
HHT325	1.9	.8	TR	TR	2.8	1.3	--	4.1	3.5	--	--	68	80	0.2	6.2	7.1
HHT325	.9	.4	TR	TR	1.4	1.0	--	2.4	2.1	--	--	58	67	0.1	6.0	6.8
HHT325	1.0	.4	0.0	TR	1.4	.8	--	2.2	1.8	--	--	64	78	0.1	5.9	6.8
HHT325	3.1	1.2	0.0	.1	4.4	2.3	--	6.7	5.1	--	--	66	86	0.3	6.2	6.9

Ft. Leonard Wood sample data 12-20-93 MISSOURI SOIL CHARACTERIZATION LABORATORY

MFLW3

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of <2mm											
HHT385	0-10	0-4	--	2.5	5.0	92.5	2.8	2.2	2.3	47.7	37.3	4.7	0.5	90.2	S
HHT385	10-15	4-6	--	7.5	17.2	75.2	9.9	7.3	5.6	52.2	15.1	2.2	0.1	69.6	FSL
HHT385	15-18	6-7	--	2.1	4.2	93.7	2.1	2.1	1.5	33.0	48.3	9.8	1.1	92.2	S
HHT385	18-30	7-12	--	1.6	7.6	90.8	4.7	3.0	2.7	43.6	39.1	5.1	0.4	88.1	S
HHT385	30-36	12-14	--	4.9	14.3	80.8	8.3	6.0	4.4	39.2	27.6	8.6	1.0	76.4	LS
HHT385	46-56	18-22	--	0.1	0.8	99.1	0.3	0.5	0.1	13.2	54.9	27.1	3.7	99.0	S
HHT385	74-84	29-33	--	0.6	0.5	99.0	0.5	0.0	0.2	25.2	62.8	10.0	0.6	98.8	S
HHT385	91-94	36-37	--	5.5	11.8	82.7	7.4	4.4	5.2	50.0	24.3	2.6	0.6	77.5	LS
HHT385	94-99	37-39	--	1.9	1.5	96.6	1.3	0.2	1.0	37.4	52.1	5.7	0.5	95.6	S
HHT385	99-104	39-41	--	6.2	12.2	81.7	6.5	5.7	5.7	44.7	23.5	6.4	1.3	76.0	LS
HHT385	117-127	46-50	--	0.1	0.3	99.5	0.3	0.0	0.2	22.4	60.0	15.2	1.8	99.3	S
HHT385	145-152	57-60	--	4.0	7.3	88.7	4.3	3.0	3.4	50.3	31.5	2.8	0.7	85.3	FS
HHT385	152-165	60-65	--	2.7	2.8	94.4	1.7	1.1	1.2	49.5	38.2	5.0	0.6	93.2	S
HHT385	165-170	65-67	--	7.7	16.3	76.0	8.4	7.9	6.4	49.7	17.1	2.0	0.8	69.6	FSL
HHT385	170-183	67-72	--	2.6	4.1	93.2	2.3	1.8	2.0	42.3	43.0	5.1	0.9	91.2	S

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACIDITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +AL	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
HHT385	1.7	.8	.1	.1	2.7	1.5	--	4.2	2.5	--	--	64	100	0.3	6.5	7.4
HHT385	3.7	1.6	0.0	.1	5.4	1.8	--	7.2	5.6	--	--	57	75	0.5	6.5	7.1
HHT385	.7	.4	0.0	TR	1.2	.6	--	1.8	1.9	--	--	67	63	0.2	6.1	6.9
HHT385	1.0	.4	0.0	TR	1.4	1.2	--	2.6	2.2	--	--	54	64	0.1	6.0	6.9
HHT385	2.4	1.2	0.0	TR	3.6	1.9	--	5.5	4.0	--	--	65	90	0.4	6.2	6.9
HHT385	0.0	.4	0.0	0.0	0.4	.7	--	1.1	.9	--	--	36	44	0.1	5.6	6.4
HHT385	0.0	0.0	TR	0.0	OR	.8	--	.8	.9	--	--	3	2	TR	5.5	6.5
HHT385	2.9	1.2	0.0	TR	4.2	1.4	--	5.6	5.1	--	--	75	82	0.4	6.0	6.7
HHT385	.5	.4	0.0	TR	0.9	1.0	--	1.9	1.5	--	--	47	60	0.1	5.8	6.7
HHT385	2.4	1.2	0.0	TR	3.6	2.5	--	6.1	4.4	--	--	59	82	0.4	6.1	6.8
HHT385	2.2	0.0	0.0	0.0	2.2	.8	--	3.0	.9	--	--	73	100	TR	5.6	6.5
HHT385	1.5	.8	0.0	TR	2.3	1.3	--	3.6	2.7	--	--	64	85	0.2	6.7	7.3
HHT385	.7	.4	TR	TR	1.1	1.4	--	2.5	2.1	--	--	44	52	0.1	6.2	6.9
HHT385	3.1	1.2	0.0	TR	4.3	2.2	--	6.5	5.4	--	--	66	80	0.4	6.3	7.1
HHT385	.9	.4	0.0	TR	1.3	.7	--	2.0	2.4	--	--	65	54	0.1	6.3	7.2

Ft. Leonard Wood sample data 12-20-93 MISSOURI SOIL CHARACTERIZATION LABORATORY

MFLW4

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of <2mm											
HH14	0-5	0-2	--	8.9	27.4	63.7	17.4	10.1	3.2	13.5	28.9	15.6	2.5	60.5	MSL
HH14	8-18	3-7	--	7.9	24.8	67.2	15.9	8.9	2.6	12.1	30.8	19.0	2.7	64.6	MSL
HH14	18-33	7-13	--	13.1	41.8	45.1	27.0	14.8	4.1	10.9	17.7	10.9	1.5	41.0	L
HH14	33-46	13-18	--	5.2	17.1	77.7	10.6	6.5	3.0	17.1	31.9	22.2	3.6	74.7	LCOS
HH14	46-56	18-22	--	1.7	4.3	93.9	3.5	0.9	0.8	15.2	48.8	27.2	2.0	93.1	COS
HH14	56-66	22-26	--	12.4	40.4	47.2	23.7	16.8	6.6	27.9	10.7	1.8	0.1	40.6	L
HH14	66-76	26-30	--	10.8	34.6	54.6	20.5	14.1	6.7	36.2	10.6	0.8	0.3	47.9	FSL
HH14	76-86	30-34	--	9.0	23.2	67.8	13.0	10.2	5.7	42.4	18.3	1.2	0.1	62.1	FSL
HH14	86-97	34-38	--	6.5	14.9	78.6	7.9	7.0	5.6	55.2	16.6	1.0	0.2	73.0	LFS
HH14	97-107	38-42	--	3.1	6.9	90.0	3.6	3.3	2.8	54.9	29.6	2.4	0.2	87.2	FS
HH14	107-117	42-46	--	1.3	1.7	97.0	1.2	0.5	0.8	36.9	48.6	8.9	1.8	96.2	S
HH14	117-127	46-50	--	1.1	2.4	96.5	0.9	1.5	0.8	38.8	49.6	6.4	0.8	95.7	S

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +AL	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
HH14	8.3	2.4	0.0	.2	11.0	2.9	--	13.9	10.5	--	--	79	100	1.7	6.8	7.2
HH14	4.6	1.5	0.0	.1	6.2	2.1	--	8.3	6.5	--	--	75	95	0.7	6.6	7.2
HH14	6.3	2.4	0.0	.1	8.8	2.3	--	11.1	9.7	--	--	79	91	1.0	6.5	7.0
HH14	2.2	.8	.1	TR	3.2	1.1	--	4.3	3.8	--	--	74	84	0.3	6.3	7.0
HH14	.7	.4	0.0	TR	1.1	.4	--	1.5	1.7	--	--	73	65	0.1	6.0	6.8
HH14	7.8	2.0	.1	.1	10.0	2.7	--	12.7	10.0	--	--	79	100	0.9	6.2	6.9
HH14	8.5	2.0	TR	.1	10.6	2.6	--	13.2	8.8	--	--	80	100	0.7	6.2	6.8
HH14	6.0	1.6	TR	.1	7.7	2.2	--	9.8	6.6	--	--	78	100	0.4	6.1	6.7
HH14	3.1	.8	TR	.1	4.0	1.4	--	5.4	4.4	--	--	74	91	0.3	6.1	6.7
HH14	4.6	.4	0.0	TR	5.0	.7	--	5.7	2.4	--	--	88	100	0.1	5.9	6.7
HH14	.5	0.0	0.0	TR	0.5	.5	--	1.0	1.2	--	--	50	42	0.1	5.7	6.6
HH14	1.0	0.0	0.0	TR	1.0	.5	--	1.5	1.2	--	--	67	83	0.1	5.6	6.7

m/lws

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of <2mm											
HHT240	0-8	0-3	--	13.7	36.6	49.7	22.3	14.3	5.7	23.4	17.0	3.3	0.4	44.0	L
HHT240	8-15	3-6	--	13.2	32.9	53.9	19.9	13.0	5.4	25.3	18.8	3.5	0.8	48.5	FSL
HHT240	15-25	6-10	--	5.2	12.5	82.2	6.4	6.2	3.0	37.4	34.7	6.2	0.9	79.2	LS
HHT240	25-36	10-14	--	7.5	24.3	68.2	16.0	8.3	3.4	28.3	28.9	6.1	1.5	64.8	MSL
HHT240	36-41	14-16	--	5.6	17.4	77.1	11.7	5.6	2.6	37.1	32.5	4.4	0.4	74.5	LS
HHT240	41-53	16-21	--	10.6	33.5	55.9	20.3	13.3	5.7	27.9	16.8	4.5	1.0	50.2	FSL
HHT240	53-69	21-27	--	11.2	35.9	52.9	21.1	14.8	5.8	29.6	13.1	3.9	0.5	47.1	FSL
HHT240	69-76	27-30	--	6.7	22.0	71.3	12.8	9.3	4.2	40.5	21.4	3.9	1.1	67.1	FSL
HHT240	76-86	30-34	--	8.0	23.6	68.4	13.0	10.6	4.8	33.0	24.4	5.2	1.0	63.6	FSL
HHT240	86-94	34-37	--	10.9	39.4	49.6	24.8	14.6	4.2	24.0	16.2	4.1	1.2	45.4	L
HHT240	97-102	38-40	--	6.1	17.1	76.8	8.9	8.1	4.7	23.5	39.9	8.4	0.3	72.1	LS
HHT240	122-127	48-50	--	1.9	2.0	96.0	0.3	1.8	1.2	26.4	58.0	10.0	0.4	94.8	S
HHT240	130-145	51-57	--	12.5	32.8	54.8	17.5	15.2	10.0	31.1	12.2	1.4	0.0	44.8	FSL
HHT240	145-157	57-62	--	2.7	5.6	91.7	2.8	2.8	2.6	54.6	32.1	2.1	0.2	89.1	FS
HHT240	157-173	62-68	--	0.1	1.3	98.6	0.9	0.4	0.7	48.8	43.9	4.7	0.5	97.9	S

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACIDITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +AL	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
HHT240	11.7	3.2	.1	.5	15.5	2.9	--	18.4	13.7	--	--	84	100	2.4	6.6	6.8
HHT240	7.9	2.4	TR	.2	10.5	1.9	--	12.4	11.2	--	--	85	94	1.6	7.0	7.3
HHT240	2.9	2.4	0.0	.1	5.4	.8	--	6.2	4.1	--	--	87	100	0.4	6.8	7.4
HHT240	3.7	1.2	.1	.1	5.1	1.0	--	6.1	5.2	--	--	84	98	0.5	6.8	7.5
HHT240	3.2	.8	TR	.1	4.1	1.0	--	5.1	4.8	--	--	80	85	0.5	6.7	7.4
HHT240	4.4	1.6	0.0	.1	6.1	1.5	--	7.6	7.1	--	--	80	86	0.5	6.7	7.5
HHT240	3.6	1.6	0.0	.1	5.3	1.9	--	7.2	6.3	--	--	74	84	0.4	6.6	7.4
HHT240	2.9	.8	0.0	TR	3.7	1.4	--	5.1	4.3	--	--	73	86	0.2	6.5	7.4
HHT240	2.5	.8	0.0	TR	3.4	1.8	--	5.2	4.2	--	--	65	81	0.2	6.5	7.4
HHT240	5.3	1.2	TR	.1	6.6	2.2	--	8.8	7.2	--	--	75	92	0.4	6.6	7.3
HHT240	2.7	.8	TR	.1	3.6	1.0	--	4.6	4.5	--	--	78	80	0.2	6.4	7.2
HHT240	.5	0.0	0.0	0.0	0.5	.5	--	1.0	1.2	--	--	50	42	TR	6.1	7.0
HHT240	5.6	2.0	TR	.1	7.7	2.5	--	10.2	8.7	--	--	75	89	0.5	6.4	7.1
HHT240	1.4	.4	.1	TR	1.9	1.2	--	3.1	2.4	--	--	61	79	0.2	6.2	7.1
HHT240	.2	0.0	0.0	0.0	0.2	.4	--	.6	1.0	--	--	33	20	TR	5.7	6.9

Ft. Leonard Wood sample data 12-20-93 MISSOURI SOIL CHARACTERIZATION LABORATORY

mflw6

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of <2mm											
RT1130	3-13	1-5	--	16.7	42.1	41.2	23.0	19.2	6.3	21.8	10.4	2.4	0.4	34.9	L
RT1130	13-23	5-9	--	18.9	49.6	31.6	27.1	22.5	7.0	17.9	5.1	1.1	0.4	24.6	L
RT1130	30-41	12-16	--	17.2	42.4	40.4	23.9	18.5	7.6	22.6	7.6	2.2	0.5	32.8	L
RT1130	41-51	16-20	--	16.9	43.1	40.0	22.7	20.4	7.5	19.6	9.7	2.7	0.6	32.5	L
RT1130	53-64	21-25	--	8.3	21.4	70.3	11.8	9.6	3.7	21.1	32.8	11.0	1.8	66.6	MSL
RT1130	64-74	25-29	--	8.1	21.4	70.5	11.2	10.2	3.6	22.2	32.8	10.9	1.1	66.9	MSL
RT1130	74-84	29-33	--	4.7	13.1	82.2	6.9	6.2	2.4	29.7	38.8	10.5	0.9	79.8	LS
RT1130	84-94	33-37	--	7.7	25.4	66.9	14.4	10.9	3.6	28.8	27.9	6.0	0.6	63.3	MSL
RT1130	94-104	37-41	--	16.5	56.6	26.9	28.7	27.9	5.9	12.1	6.6	2.0	0.2	21.0	SIL
RT1130	104-114	41-45	--	14.9	42.3	42.8	22.9	19.5	6.8	29.1	4.7	1.4	0.7	36.0	L
RT1130	114-124	45-49	--	20.5	45.3	34.2	21.6	23.7	11.3	17.7	2.4	2.0	0.8	22.9	L
RT1130	127-135	50-53	--	2.8	1.0	96.2	0.0	1.0	0.2	5.7	36.5	41.9	11.9	96.0	COS
RT1130	142-152	56-60	--	6.1	5.8	88.1	1.9	3.9	1.2	11.8	27.7	16.3	31.1	86.9	LCOS

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +AL	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g											%				
RT1130	4.8	1.6	0.0	.1	6.5	3.8	--	10.3	9.1	--	--	63	71	0.8	5.7	6.3
RT1130	4.7	1.6	0.0	.1	6.4	3.9	--	10.3	9.1	--	--	62	70	0.2	5.6	6.3
RT1130	4.6	1.2	0.0	.1	5.9	3.4	--	9.3	9.0	--	--	63	66	0.2	5.5	6.2
RT1130	4.1	1.2	0.0	.1	5.4	3.8	--	9.2	8.7	--	--	59	62	0.2	5.4	6.2
RT1130	2.2	.8	0.0	.1	3.1	2.4	--	5.5	4.8	--	--	56	65	0.1	5.3	6.1
RT1130	2.2	.4	TR	.1	2.7	2.3	--	5.0	4.5	--	--	54	60	0.1	5.3	6.1
RT1130	1.4	.4	0.0	TR	1.8	1.5	--	3.3	3.2	--	--	55	56	TR	5.2	6.1
RT1130	1.9	.4	0.0	.1	2.4	1.9	--	4.3	4.5	--	--	56	53	0.1	5.3	6.2
RT1130	3.6	1.6	0.0	.2	5.4	3.5	--	8.8	8.5	--	--	61	64	0.2	5.4	6.2
RT1130	3.9	1.6	0.0	.1	5.6	3.1	--	8.7	7.7	--	--	64	73	0.1	5.4	6.2
RT1130	5.0	2.0	0.0	.1	7.1	3.7	--	10.8	10.3	--	--	66	69	0.2	5.5	6.2
RT1130	1.0	.4	0.0	TR	1.4	1.0	--	2.4	2.0	--	--	58	70	0.1	5.3	6.2
RT1130	1.9	.8	0.0	.1	2.8	2.1	--	4.9	4.1	--	--	57	68	0.1	5.4	6.2

u-f/w 7

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of <2mm											
RT230	0-5	0-2	--	15.1	78.1	6.8	47.3	30.7	3.8	2.2	0.4	0.3	0.2	3.0	SIL
RT230	10-20	4-8	--	19.6	74.6	5.8	47.3	27.4	3.1	1.9	0.2	0.1	0.5	2.7	SIL
RT230	20-30	8-12	--	20.8	73.8	5.4	47.5	26.3	3.2	1.9	0.2	0.1	0.0	2.2	SIL
RT230	30-38	12-15	--	22.3	72.0	5.8	46.7	25.3	3.1	2.1	0.2	0.1	0.4	2.7	SIL
RT230	38-48	15-19	--	21.7	73.4	4.9	45.5	27.9	2.7	1.9	0.1	0.1	0.0	2.2	SIL
RT230	48-58	19-23	--	22.9	71.4	5.6	46.7	24.7	3.1	2.0	0.1	0.1	0.3	2.5	SIL
RT230	58-69	23-27	--	22.4	71.9	5.7	45.6	26.4	3.4	2.1	0.1	0.1	0.0	2.3	SIL
RT230	81-91	32-36	--	22.8	69.1	8.1	41.2	27.9	4.2	3.4	0.2	0.1	0.3	3.9	SIL
RT230	91-102	36-40	--	22.8	68.8	8.4	41.9	26.8	4.8	3.3	0.3	0.1	0.0	3.6	SIL
RT230	102-112	40-44	--	22.2	70.9	6.9	41.9	29.0	4.4	2.2	0.1	0.0	0.2	2.5	SIL
RT230	112-122	44-48	--	22.8	69.8	7.3	42.4	27.4	3.9	3.1	0.3	0.0	0.0	3.4	SIL
RT230	127-137	50-54	--	20.9	69.5	9.6	41.0	28.5	3.9	4.4	0.9	0.2	0.2	5.7	SIL
RT230	137-147	54-58	--	21.4	67.0	11.6	41.1	25.9	3.7	5.5	2.0	0.5	0.0	7.9	SIL
RT230	147-157	58-62	--	17.0	52.4	30.6	32.0	20.5	2.5	7.7	8.2	5.3	6.9	28.1	SIL
RT230	173-183	68-72	--	12.6	11.8	75.6	8.2	3.6	0.4	6.0	19.0	20.8	29.3	75.2	COSL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	------CEC------ SUM CATS	NH4 OAc	BASES +AL	Al SAT	BASE SAT SUM	NH4 OAc	ORG C	---pH---- CaCl2 .01M	H2O
	-------------------------					meq/100 g				------------------	---------	%	---------			
RT230	6.9	1.6	0.0	.6	9.1	7.7	--	16.8	13.2	--	--	54	69	2.8	5.4	5.9
RT230	4.2	1.2	0.0	.3	5.7	5.9	--	11.6	9.6	--	--	49	59	0.6	5.0	5.7
RT230	5.0	1.2	0.0	.2	6.4	5.6	--	12.0	9.5	--	--	53	67	0.3	5.0	5.8
RT230	5.3	1.2	.1	.2	6.8	5.7	--	12.5	10.5	--	--	54	65	0.3	5.0	5.8
RT230	5.3	1.2	TR	.2	6.7	5.9	--	12.6	10.5	--	--	53	64	0.3	5.0	5.7
RT230	4.9	1.6	0.0	.2	6.7	6.3	--	13.0	10.7	--	--	52	63	0.3	4.9	5.7
RT230	4.8	1.6	TR	.2	6.6	6.3	--	12.9	11.5	--	--	51	57	0.2	4.9	5.6
RT230	4.8	1.2	0.0	.2	6.2	5.9	--	12.1	11.4	--	--	51	54	0.3	4.9	5.6
RT230	5.0	1.6	0.0	.2	6.8	5.8	--	12.6	10.6	--	--	54	64	0.2	4.8	5.6
RT230	4.6	2.0	TR	.2	6.8	6.3	--	13.1	11.4	--	--	52	60	0.2	5.0	5.6
RT230	4.6	1.6	.2	.3	6.7	5.9	--	12.6	11.3	--	--	53	59	0.2	4.9	5.6
RT230	5.3	1.6	.1	.3	7.3	5.6	--	12.9	11.0	--	--	57	66	0.2	4.9	5.6
RT230	5.1	1.6	.1	.2	7.0	5.9	--	12.9	10.5	--	--	54	67	0.2	4.9	5.7
RT230	3.4	1.6	0.0	.1	5.1	4.2	--	9.3	8.3	--	--	55	61	0.2	4.9	5.7
RT230	3.0	1.2	0.0	.1	4.3	3.2	--	7.5	6.6	--	--	57	65	0.1	5.0	5.7

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
RT310	0-15	0-6		22.8	73.4	3.8	43.3	30.1	3.0	0.7	0.1	0.0	0.0	0.8	SIL
RT310	15-25	6-10		22.1	74.6	3.3	46.2	28.5	2.6	0.6	0.1	0.0	0.0	0.7	SIL
RT310	25-36	10-14		23.5	74.2	2.2	48.4	25.9	1.7	0.4	0.1	0.1	0.0	0.5	SIL
RT310	36-46	14-18		20.3	66.3	13.3	38.0	28.3	7.5	5.0	0.7	0.2	0.0	5.9	SIL
RT310	46-56	18-22		16.9	54.0	29.1	28.8	25.2	11.0	15.8	2.1	0.2	0.0	18.1	SIL
RT310	56-66	22-26		18.9	50.6	30.5	26.0	24.6	16.9	12.7	0.7	0.1	0.0	13.6	SIL
RT310	66-76	26-30		8.1	21.9	69.9	11.2	10.8	6.2	52.2	10.4	1.1	0.0	63.8	FSL
RT310	76-86	30-34		8.0	22.3	69.7	13.1	9.2	8.0	50.7	10.0	0.9	0.0	61.6	FSL
RT310	86-94	34-37		16.3	43.1	40.6	23.8	19.3	10.5	27.8	2.3	0.2	0.0	30.2	L
RT310	97-107	38-42		10.7	19.4	69.9	11.2	8.2	7.1	55.6	6.8	0.4	0.0	62.8	FSL
RT310	114-124	45-49		14.7	35.0	50.4	18.9	16.0	9.7	36.2	4.1	0.4	0.0	40.6	L
RT310	127-137	50-54		2.0	4.8	93.3	2.1	2.6	4.4	74.9	13.5	0.5	0.0	88.9	FS
RT310	147-157	58-62		0.7	1.8	97.4	0.6	1.2	0.6	37.7	46.0	10.6	2.5	96.8	S
R11225	-	-		21.2	52.1	26.6	32.5	19.7	2.9	7.7	6.6	4.1	5.2	23.7	SIL
R12	-	-		12.9	12.8	74.2	9.0	3.9	2.8	10.0	19.2	19.7	22.6	71.4	COSL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACIDITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
RT310	13.1	3.5	0.0	.2	16.8	4.8	--	21.6	16.3	--	--	78	100	1.5	6.3	6.8
RT310	9.5	3.2	0.0	.2	12.9	5.3	--	18.2	15.2	--	--	71	85	1.1	6.1	6.6
RT310	9.0	3.5	0.0	.2	12.7	5.4	--	18.1	15.3	--	--	70	83	1.1	6.2	6.7
RT310	8.3	3.2	0.0	.2	11.8	5.4	--	17.2	14.2	--	--	69	83	1.0	6.0	6.6
RT310	6.4	2.4	0.0	.1	8.8	3.8	--	12.7	11.1	--	--	70	80	0.7	6.1	6.8
RT310	6.9	2.7	TR	.2	9.8	4.0	--	13.8	12.3	--	--	71	80	0.7	6.1	6.8
RT310	3.2	1.2	0.0	.1	4.5	2.4	--	6.9	5.6	--	--	65	80	0.3	6.0	6.7
RT310	3.0	1.2	0.0	.1	4.3	2.7	--	7.0	5.9	--	--	61	73	0.4	6.0	6.7
RT310	7.5	2.8	.1	.2	10.6	3.5	--	14.1	10.3	--	--	75	100	0.7	6.0	6.7
RT310	4.5	1.6	TR	.2	6.3	2.6	--	8.8	7.0	--	--	71	90	0.4	6.1	6.7
RT310	6.5	2.0	TR	.2	8.7	3.6	--	12.3	10.2	--	--	71	85	0.8	6.1	6.6
RT310	1.2	.4	0.0	TR	1.6	1.1	--	2.7	1.9	--	--	59	84	TR	5.7	6.6
RT310	.7	.4	0.0	TR	1.1	1.0	--	2.1	1.4	--	--	52	79	0.1	5.6	6.5
R11225	4.3	2.0	TR	.2	6.5	4.7	--	11.2	9.7	--	--	58	67	0.3	5.4	6.1
R12 gravel	2.9	1.2	TR	.2	4.3	2.5	--	6.8	5.9	--	--	63	73	0.1	5.4	6.2

[illegible] [illegible] [illegible] Sample - there were no [illegible] that [illegible] [illegible] these samples. Full characterization was [illegible]. Please [illegible] data to Dr. [illegible]mmer.

FLW-1

Sample Point	Depth in inches	Total Weight	Gravel Weight	% Gravel
FLW HH T1 20'	3-4.5	312	20	6
FLW HH T1 20'	4.5-9	642	1	0
FLW HH T1 20'	9 - 11	379	2	1
FLW HH T1 20'	11 - 14	435	1	0
FLW HH T1 20'	14-17	448	2	0
FLW HH T1 20'	17-20	471	2	0
FLW HH T1 20'	20-23	482	0	0
FLW HH T1 20'	23-26	409	0	0
FLW HH T1 20'	26-29	433	0	0
FLW HH T1 20'	29-34	549	2	0
FLW HH T1 20'	34-39	652	1	0
FLW HH T1 20'	39-44	748	4	1
FLW HH T1 20'	44-49	659	2	0
FLW HH T1 20'	49-54	806	0	0
FLW HH T1 20'	54-59	944	0	0
FLW HH T1 20'	59-64	657	3	0
FLW HH T1 20'	64-69	236	1	0
FLW HH T1 70'	18-21	384	2	1
FLW HH T1 70'	21-23	304	4	1
FLW HH T1 70'	24-27	453	11	2
FLW HH T1 70'	30-33	226	0	0
FLW HH T1 70'	36-39	478	0	0
FLW HH T1 70'	45-48	484	24	5
FLW HH T3 25'	0-2.5	341	8	2
FLW HH T3 25'	2.5-4	469	22	5
FLW HH T3 25'	5 - 9	387	72	19
FLW HH T3 25'	9.5-11	375	83	22
FLW HH T3 25'	12 - 15	528	4	1
FLW HH T3 25'	21-24	472	4	1
FLW HH T3 25'	28-34	717	20	3
FLW HH T3 25'	40-42	222	9	4
FLW HH T3 25'	42-45	352	0	0
FLW HH T3 25'	50-53	588	62	11
FLW HH T3 25'	53-58	570	0	0
FLW HH T3 25'	58-63	715	4	1
FLW HH T3 25'	63-65	3098	2838	92
FLW HH T3 25'	65-66.5	318	9	3
FLW HH T3 25'	66.5-68	215	1	0

[illegible]

FLW HH T3 85'	0-4	560	6	1
FLW HH T3 85'	4 - 6	507	0	0
FLW HH T3 85'	6 - 7	313	0	0
FLW HH T3 85'	7 - 12	751	2	0
FLW HH T3 85'	12 - 14	327	1	0
FLW HH T3 85'	18-22	597	10	2
FLW HH T3 85'	29-33	496	0	0
FLW HH T3 85'	36-37	73	0	0
FLW HH T3 85'	37-39	99	0	0
FLW HH T3 85'	39-41	239	0	0
FLW HH T3 85'	46-50	475	1	0
FLW HH T3 85'	57-60	574	0	0
FLW HH T3 85'	60-65	310	0	0
FLW HH T3 85'	65-67	141	0	0
FLW HH T3 85'	67-72	224	2	1
FLW HH 14'	0-2	97	2	2
FLW HH 14'	3 - 7	121	1	1
FLW HH 14'	7 - 13	343	2	1
FLW HH 14'	13-18	218	9	4
FLW HH 14'	18-22	163	3	2
FLW HH 14'	22-26	174	0	0
FLW HH 14'	26-30	210	0	0
FLW HH 14'	30-34	214	0	0
FLW HH 14'	34-38	196	0	0
FLW HH 14'	38-42?	200	0	0
FLW HH 14'	42-46	199	1	1
FLW HH 14'	46-50	167	0	0
FLW HH T2 40'	0-3	465	0	0
FLW HH T2 40'	3 - 6	539	1	0
FLW HH T2 40'	6 - 10	530	16	3
FLW HH T2 40'	10 - 14	487	32	7
FLW HH T2 40'	14-16	173	0	0
FLW HH T2 40'	16-21	348	4	1
FLW HH T2 40'	21-27	710	3	0
FLW HH T2 40'	27-30	893	1	0
FLW HH T2 40'	30-34	610	4	1
FLW HH T2 40'	34-37	414	1	0
FLW HH T2 40'	38-40	238	0	0
FLW HH T2 40'	48-50	332	0	0
FLW HH T2 40'	51-57	352	0	0
FLW HH T2 40'	57-62	342	0	0
FLW HH T2 40'	62-68	278	0	0

FLW RT1 130'	1 - 5	647	3	0
FLW RT1 130'	5 - 9	649	1	0
FLW RT1 130'	12 - 16	739	21	3
FLW RT1 130'	16-20	716	1	0
FLW RT1 130'	21-25	709	1	0
FLW RT1 130'	25-29	743	0	0
FLW RT1 130'	29-33	693	0	0
FLW RT1 130'	33-37	695	0	0
FLW RT1 130'	37-41	606	0	0
FLW RT1 130'	41-45	633	1	0
FLW RT1 130'	45-49	650	3	0
FLW RT1 130'	50-53	610	75	12
FLW RT1 130'	56-60	658	521	79
FLW RT2 30'	0-2	362	0	0
FLW RT2 30'	4 - 8	508	0	0
FLW RT2 30'	8 - 12	598	0	0
FLW RT2 30'	12 - 15	585	0	0
FLW RT2 30'	15-19	613	0	0
FLW RT2 30'	19-23	528	0	0
FLW RT2 30'	23-27	568	0	0
FLW RT2 30'	32-36	614	0	0
FLW RT2 30'	36-40	592	0	0
FLW RT2 30'	40-44	668	0	0
FLW RT2 30'	44-48	559	0	0
FLW RT2 30'	50-54	612	0	0
FLW RT2 30'	54-58	621	0	0
FLW RT2 30'	58-62	767	591	77
FLW RT2 30'	68-72	906	782	86
FLW RT3 10'	0-6	471	0	0
FLW RT3 10'	6 - 10	365	0	0
FLW RT3 10'	10 - 14	302	0	0
FLW RT3 10'	14-18	251	0	0
FLW RT3 10'	18-22	272	0	0
FLW RT3 10'	22-26	361	0	0
FLW RT3 10'	26-30	496	0	0
FLW RT3 10'	30-34	391	0	0
FLW RT3 10'	34-37	235	0	0
FLW RT3 10'	38-42	386	0	0
FLW RT3 10'	45-49	344	0	0
FLW RT3 10'	50-54	474	0	0
FLW RT3 10'	58-62	454	72	16
FLW R12 Gravel	?	1192	733	61
FLW R11 225'	?	859	344	40

Ft. Leonard Wood sample data 1-18-94 MISSOURI SOIL CHARACTERIZATION LABORATORY

[illegible] 9

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
URT135	0-13	0-5		11.8	49.1	39.1	29.7	19.4	3.2	18.0	11.5	4.3	2.1	35.9	L
URT135	13-23	5-9		35.4	49.5	15.1	36.9	12.6	1.4	6.6	4.4	1.7	1.1	13.7	SICL
URT135	23-33	9-13		35.5	49.4	15.1	35.8	13.6	1.4	7.7	3.8	1.6	0.6	13.7	SICL
URT135	33-41	13-16		34.6	46.6	18.8	33.9	12.8	1.5	7.8	5.0	2.2	2.4	17.3	SICL
URT135	41-48	16-19		31.4	44.2	24.5	31.7	12.5	1.8	10.8	6.9	2.7	2.3	22.7	CL
URT135	48-56	19-22		27.9	43.9	28.2	32.4	11.4	1.9	12.3	9.1	3.3	1.5	26.3	CL
URT135	56-66	22-26		30.2	43.0	26.7	30.9	12.2	1.9	12.4	8.3	3.1	1.1	24.9	CL
URT135	66-76	26-30		27.7	40.4	31.9	28.7	11.7	2.0	13.1	10.4	3.8	2.5	29.9	CL
URT135	76-86	30-34		25.8	36.1	38.1	25.8	10.2	2.0	15.0	13.0	4.9	3.3	36.1	L
URT135	86-94	34-37		20.4	31.6	48.0	22.1	9.6	2.4	16.4	13.7	5.6	10.0	45.6	L
URT135	94-102	37-40		23.5	32.2	44.3	23.2	9.1	2.5	16.7	11.7	4.7	8.7	41.8	L
URT135	102-112	40-44		17.7	27.1	55.2	20.2	6.8	2.2	17.7	17.4	8.5	9.5	53.0	MSL
URT135	112-122	44-48		15.7	24.8	59.5	17.6	7.2	2.7	22.7	20.8	8.0	5.3	56.8	MSL
URT135	122-130	48-51		23.7	39.3	37.0	28.9	10.4	2.1	15.8	12.6	4.8	1.7	34.9	L
URT135	130-137	51-54		28.5	32.5	39.0	21.9	10.6	2.3	17.4	13.2	4.7	1.3	36.7	CL
URT180	91-102	36-40		28.7	30.3	41.1	21.2	9.0	2.0	13.0	11.6	6.0	8.4	39.0	CL
URT180	102-112	40-44		27.9	30.3	41.8	21.0	9.3	2.2	15.4	11.1	5.1	8.0	39.6	CL
URT180	112-122	44-48		23.9	28.7	47.4	19.3	9.4	2.0	14.2	13.7	7.2	10.3	45.4	L

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	NH4 OAc	BASES +Al	Al SAT	BASE SAT SUM	NH4 OAc	ORG C	pH CaCl2 .01M	H2O
	meq/100 g										%					
URT135	2.6	1.2	.1	.2	4.1	5.2	.4	9.3	8.0	4.5	9	44	51	0.8	4.8	5.3
URT135	5.5	4.7	TR	.3	10.5	8.8	.3	19.4	18.1	10.8	3	54	58	0.3	4.8	5.4
URT135	5.5	5.9	.1	.3	11.8	9.6	1.0	21.4	19.5	12.8	8	55	61	0.3	4.8	5.4
URT135	5.3	6.0	TR	.4	11.7	9.6	1.1	21.3	19.4	12.8	9	55	60	0.3	4.9	5.4
URT135	4.6	5.2	.2	.3	10.3	7.6	1.0	17.9	17.2	11.3	9	58	60	0.2	4.9	5.5
URT135	4.3	5.5	.1	.3	10.2	7.0	.8	17.2	16.6	11.0	7	59	61	0.2	4.8	5.6
URT135	4.7	5.8	.1	.3	10.9	6.8	.7	17.7	17.1	11.6	6	62	64	0.2	4.9	5.5
URT135	4.8	5.9	.1	.3	11.1	6.4	.6	17.5	16.3	11.7	5	63	68	0.2	5.0	5.6
URT135	4.3	5.5	.1	.3	10.2	5.4	.5	15.6	15.1	10.7	5	65	68	0.1	5.0	5.6
URT135	3.3	3.9	.1	.2	7.5	3.2	.2	10.7	10.5	7.7	3	70	71	0.1	5.1	5.8
URT135	3.6	4.0	.1	.2	7.9	3.6	.1	11.5	11.2	8.0	1	69	71	0.1	5.2	6.0
URT135	2.4	2.4	.1	.1	5.0	2.2	0.0	7.2	6.8	5.0	0	69	74	0.1	5.3	6.1
URT135	2.2	2.0	.1	.1	4.4	1.8	0.0	6.2	6.1	4.4	0	71	72	TR	5.3	6.2
URT135	2.6	2.4	.1	.1	5.2	1.7	0.0	6.9	6.9	5.2	0	75	75	0.1	5.4	6.2
URT135	3.9	3.6	.1	.3	7.9	2.5	.1	10.4	10.6	8.0	1	76	75	0.1	5.6	6.3
URT180	4.1	5.5	.1	.2	9.8	5.5	--	15.4	13.4	--	--	64	74	0.1	5.2	6.0
URT180	4.1	4.4	.1	.3	8.8	4.7	--	13.6	12.5	--	--	65	71	0.1	5.2	6.0
URT180	3.8	4.3	.1	.2	8.3	4.3	--	12.7	12.0	--	--	66	70	0.1	5.4	5.8

mtl/w10

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
URT195	0-13	0-5		10.8	55.2	34.1	30.3	24.9	2.4	13.8	9.8	4.6	3.5	31.6	SIL
URT195	13-23	5-9		26.7	54.2	19.2	35.5	18.6	1.4	7.2	5.2	2.9	2.5	17.8	SIL
URT195	23-38	9-15		44.0	41.8	14.2	28.2	13.7	1.0	5.9	4.5	1.9	1.0	13.2	SIC
URT195	38-51	15-20		41.9	42.1	16.1	28.8	13.3	1.0	6.7	5.3	2.2	0.8	15.0	SIC
URT195	51-61	20-24		36.1	47.3	16.6	31.1	16.2	1.2	7.2	5.2	2.1	0.8	15.4	SICL
URT195	61-74	24-29		37.1	40.9	22.0	28.2	12.7	1.5	10.1	7.6	2.3	0.4	20.5	CL
URT195	74-84	29-33		31.2	35.2	33.7	23.6	11.5	1.8	14.1	12.1	4.5	1.1	31.8	CL
URT195	84-94	33-37		28.9	32.0	39.0	20.9	11.2	2.0	15.1	13.6	5.9	2.5	37.0	CL
URT195	94-104	37-41		28.3	30.7	41.0	19.2	11.5	2.2	16.0	13.7	6.2	3.0	38.8	CL
URT195	104-117	41-46		26.6	30.1	43.4	18.9	11.2	2.6	17.3	14.7	6.2	2.6	40.8	L
URT195	117-127	46-50		27.7	29.7	42.5	18.4	11.4	2.6	17.0	13.5	6.1	3.2	39.9	CL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
URT195	2.1	1.2	TR	.1	3.4	5.5	.3	8.8	8.1	3.7	8	38	42	0.9	4.7	5.4
URT195	4.5	4.3	TR	.2	9.0	6.3	.5	15.3	14.6	9.5	5	59	62	0.4	5.0	5.6
URT195	7.3	8.2	.2	.4	16.1	11.0	1.8	27.1	24.5	17.9	10	59	66	0.3	4.7	5.3
URT195	7.0	8.0	.1	.4	15.5	10.8	1.8	26.3	23.5	17.3	10	59	66	0.3	4.7	5.0
URT195	5.8	7.3	.1	.3	13.5	9.2	1.4	22.7	21.0	14.9	9	59	64	0.2	4.7	5.2
URT195	6.1	7.5	.2	.3	14.1	8.1	1.3	22.2	21.2	15.4	8	64	67	0.2	4.7	5.3
URT195	5.0	5.9	.1	.3	11.3	6.6	.6	17.9	16.9	11.9	5	63	67	0.2	5.1	5.6
URT195	4.7	5.4	.1	.2	10.4	5.5	.3	15.9	15.6	10.7	3	65	67	0.1	5.4	5.9
URT195	4.6	5.1	.1	.2	10.0	4.6	.2	14.6	13.8	10.2	2	68	72	0.1	5.5	5.9
URT195	4.5	4.7	.1	.2	9.5	4.8	.2	14.3	13.9	9.7	2	66	68	0.1	5.6	6.2
URT195	4.7	4.7	.1	.2	9.7	4.8	0.0	14.5	13.6	9.7	0	67	71	0.2	5.9	6.4

[illegible]

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
URT210	0-10	0-4		11.2	46.6	42.2	27.7	18.9	2.7	17.4	13.0	5.5	3.5	39.4	L
URT210	10-18	4-7		11.5	46.4	42.1	26.7	19.6	2.7	17.6	13.5	5.7	2.6	39.4	L
URT210	18-30	7-12		18.6	46.5	34.9	30.1	16.4	2.6	15.0	10.8	4.2	2.2	32.3	L
URT210	30-38	12-15		34.4	41.1	24.5	26.1	15.0	2.3	11.0	8.0	2.5	0.7	22.2	CL
URT210	38-56	15-22		36.0	40.8	23.2	25.7	15.1	2.4	10.5	7.3	2.6	0.4	20.7	CL
URT210	56-69	22-27		27.5	45.9	26.6	28.6	17.3	3.1	12.6	8.1	2.5	0.3	23.5	CL
URT210	69-81	27-32		26.1	47.8	26.1	29.5	18.3	3.4	12.8	7.4	2.2	0.3	22.8	L
URT210	81-94	32-37		23.8	46.7	29.5	28.7	18.0	3.6	12.8	8.6	3.4	1.1	25.9	L
URT210	94-104	37-41		22.8	49.1	28.1	29.4	19.8	3.8	12.3	7.7	3.1	1.2	24.3	L
URT210	104-112	41-44		19.4	49.0	31.6	28.9	20.1	4.1	13.2	8.4	3.8	2.1	27.5	L
URT210	112-119	44-47		18.6	48.0	33.4	28.3	19.7	4.2	12.4	7.2	4.5	5.1	29.2	L
URT210	119-137	47-54		24.2	41.7	34.0	26.5	15.3	2.8	5.6	4.0	6.0	15.6	31.3	L
URT250	0-15	0-6		9.2	51.7	39.1	32.0	19.7	3.2	16.0	12.0	5.0	2.9	35.9	SIL
URT250	15-30	6-12		18.3	52.2	29.6	33.9	18.3	2.7	11.9	8.6	3.8	2.6	26.9	SIL
URT250	30-41	12-16		29.4	46.0	24.6	31.1	14.9	2.5	9.9	7.5	3.1	1.5	22.1	CL
URT250	41-51	16-20		40.1	39.6	20.3	25.8	13.8	2.2	8.2	6.1	2.7	1.1	18.2	C
URT250	51-61	20-24		56.1	25.2	18.7	14.4	10.8	1.3	4.0	2.8	2.4	8.2	17.4	C
URT250	61-76	24-30		23.1	36.1	40.7	23.0	13.1	1.6	2.8	2.4	7.5	26.4	39.2	L
URT250	76-91	30-36		27.4	31.3	41.3	19.8	11.5	1.4	3.1	4.3	10.9	21.6	39.9	CL
URT250	91-102	36-40		28.2	22.9	48.9	14.2	8.7	1.0	4.1	7.8	14.2	21.9	47.9	SCL
URT250	102-112	40-44		32.5	5.6	61.9	3.2	2.3	1.1	9.3	16.8	16.6	18.1	60.8	SCL

SAMPLE #	NH4OAc EXTRACTABLE BASES					ACID-ITY	EXTR Al	------CEC------			Al SAT	BASE SAT		ORG C	---pH----	
	Ca	Mg	Na	K	SUM BASES			SUM CATS	NH4 OAc	BASES +Al		SUM	NH4 OAc		CaCl2 .01M	H2O
	--------------------------meq/100 g							-----------------			---------%--------					
URT210	2.4	1.2	TR	.1	3.7	5.9	.5	9.6	8.5	4.2	12	39	44	1.0	4.7	5.3
URT210	1.9	1.2	TR	.1	3.2	6.0	.6	9.2	8.0	3.8	16	35	40	0.6	4.6	5.3
URT210	3.8	2.4	TR	.2	6.4	6.7	.7	13.1	11.2	7.1	10	49	57	0.6	4.7	5.2
URT210	5.6	5.4	.1	.2	11.3	9.5	1.6	20.8	18.0	12.9	12	54	63	0.3	4.7	5.2
URT210	5.6	5.4	.1	.2	11.3	9.8	2.0	21.1	18.8	13.3	15	54	60	0.3	4.6	5.2
URT210	3.2	3.4	.1	.1	6.8	6.7	1.3	13.5	12.3	8.1	16	50	55	0.1	4.6	5.3
URT210	3.5	3.5	.1	.1	7.2	6.5	.8	13.7	12.3	8.0	10	53	59	0.2	5.0	5.6
URT210	3.3	3.5	.1	.1	7.0	5.8	.6	12.8	12.5	7.6	8	55	56	0.2	4.9	5.6
URT210	3.1	3.2	.1	.1	6.5	4.9	.4	11.4	11.0	6.9	6	57	59	0.1	5.0	5.7
URT210	2.4	2.4	.1	.1	5.0	4.4	.3	9.3	9.0	5.3	6	53	56	0.1	5.0	5.7
URT210	2.6	2.7	.1	.1	5.5	5.1	.2	10.6	8.8	5.7	4	52	62	0.1	5.0	5.8
URT210	3.0	2.7	.2	.2	6.1	5.5	.1	11.6	11.3	6.2	2	53	54	0.1	5.5	6.3
URT250	1.7	3.1	TR	.1	4.9	5.5	.4	10.4	7.4	5.3	8	47	66	0.8	4.8	5.5
URT250	2.6	6.3	TR	.1	9.0	5.9	.5	14.9	10.2	9.5	5	60	88	0.3	5.2	5.7
URT250	4.0	3.5	.1	.2	7.8	8.3	1.1	16.1	14.6	8.8	12	48	53	0.4	4.8	5.4
URT250	5.2	5.1	.1	.2	10.6	10.9	1.7	21.5	18.1	12.3	14	49	59	0.5	4.6	5.3
URT250	7.0	7.3	.2	.3	14.8	16.9	5.4	31.7	28.3	20.2	27	47	52	0.5	4.4	5.1
URT250	2.9	2.7	.1	.1	5.8	7.4	1.5	13.2	11.8	7.3	21	44	49	0.1	4.6	5.5
URT250	2.8	3.1	.1	.1	6.1	7.6	1.2	13.7	12.3	7.3	16	45	50	0.1	4.9	5.7
URT250	3.0	3.1	.1	.1	6.3	6.6	1.1	12.9	11.9	7.4	15	49	53	0.1	4.7	5.5
URT250	4.4	4.6	.2	.2	9.3	6.6	.6	16.0	14.9	10.0	6	59	63	0.1	4.9	5.6

m.f/(a)/2

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
URT2140	0-20	0-8		14.7	55.9	29.4	34.7	21.3	3.6	13.6	7.0	3.5	1.7	25.8	SIL
URT2140	20-41	8-16		32.1	47.3	20.6	31.7	15.5	2.9	9.6	5.0	2.5	0.7	17.7	CL
URT2140	41-61	16-24		24.3	50.7	25.0	31.1	19.6	3.4	11.2	5.7	3.1	1.7	21.6	SIL
URT2140	61-76	24-30		24.0	49.4	26.6	30.3	19.1	3.6	11.9	6.1	3.5	1.6	23.1	L
URT2140	76-91	30-36		20.1	48.6	31.2	29.5	19.2	4.0	13.0	6.9	4.1	3.2	27.2	L
URT2140	91-112	36-44		21.0	44.5	34.6	27.3	17.2	3.7	12.3	6.5	4.4	7.8	30.9	L
URT2140	112-122	44-48		38.3	25.5	36.2	15.6	9.9	3.3	14.7	9.4	5.4	3.5	32.9	CL
URT2140	122-137	48-54		27.5	29.1	43.4	16.4	12.7	3.7	16.5	11.0	7.0	5.2	39.7	CL
URT330	0-15	0-6		14.2	55.5	30.3	31.0	24.5	5.6	15.1	5.6	2.6	1.3	24.7	SIL
URT330	15-36	6-14		23.7	54.8	21.6	33.3	21.5	4.4	9.6	3.5	2.4	1.7	17.2	SIL
URT330	36-46	14-18		30.2	45.7	24.1	27.7	18.0	4.1	8.6	3.7	4.0	3.7	20.0	CL
URT330	46-56	18-22		32.9	43.8	23.3	25.8	18.1	3.7	8.5	4.2	4.1	2.8	19.7	CL
URT330	56-66	22-26		36.0	43.6	20.5	25.7	17.9	3.0	6.9	4.3	4.4	1.9	17.4	CL
URT330	66-76	26-30		34.4	36.0	29.6	22.1	13.9	2.4	6.3	5.5	7.2	8.1	27.1	CL
URT330	76-91	30-36		33.7	38.6	27.7	24.6	14.0	2.2	6.6	6.7	7.4	4.8	25.5	CL
URT330	91-107	36-42		13.3	30.9	55.8	21.3	9.6	1.7	10.1	10.8	14.0	19.1	54.0	COSL
URT330	107-122	42-48		18.2	26.3	55.5	15.8	10.5	2.7	15.1	13.7	11.9	12.1	52.8	MSL
URT330	122-137	48-54		23.0	33.4	43.6	19.7	13.7	3.8	16.0	11.5	7.3	5.0	39.9	L
URT330	137-152	54-60		19.0	24.1	56.9	15.9	8.2	1.8	10.2	11.6	13.6	19.6	55.1	COSL
URT330	152-173	60-68		10.3	9.4	80.4	6.2	3.2	0.5	4.9	12.8	27.2	35.0	79.9	LCOS

SAMPLE #	NH4OAc EXTRACTABLE BASES					ACID-ITY	EXTR Al	------CEC------			Al SAT	BASE SAT		ORG C	---pH----	
	Ca	Mg	Na	K	SUM BASES			SUM CATS	NH4 OAc	BASES +Al		SUM	NH4 OAc		CaCl2 .01M	H2O
	---------------------------meq/100 g							-----------------			---------%--------					
URT2140	3.1	1.2	TR	.2	4.5	7.4	.1	11.9	9.8	4.6	2	38	45	1.0	5.4	6.2
URT2140	6.7	2.7	.1	.3	9.8	8.1	.4	17.9	16.8	10.2	4	55	58	0.3	5.2	5.9
URT2140	2.6	1.2	.1	.1	4.0	8.7	2.7	12.7	10.9	6.7	40	31	37	0.1	4.3	5.3
URT2140	1.0	.8	.1	.1	2.0	9.7	4.5	11.7	11.1	6.5	69	17	18	0.1	4.1	5.2
URT2140	.5	.8	.1	.1	1.5	8.1	4.0	9.6	8.7	5.5	73	16	17	0.1	4.0	5.1
URT2140	1.0	.8	.1	.1	2.0	7.7	3.4	9.7	9.3	5.4	63	21	22	0.1	4.1	5.1
URT2140	3.6	3.5	.4	.2	7.7	12.4	5.5	20.1	19.3	13.2	42	38	40	0.1	4.2	4.7
URT2140	2.9	2.8	.3	.1	6.1	8.6	3.5	14.7	13.8	9.6	36	41	44	0.1	4.2	4.8
URT330	2.4	.4	TR	.2	3.0	5.3	.2	8.3	7.1	3.2	6	36	42	0.6	5.3	5.9
URT330	4.1	.8	0.0	.2	5.1	5.8	.1	10.9	10.0	5.2	2	47	51	0.3	5.0	5.7
URT330	6.3	2.0	TR	.3	8.6	6.3	.2	14.9	12.7	8.8	2	58	68	0.2	5.0	5.7
URT330	7.3	2.3	TR	.3	9.8	6.1	.2	16.0	14.1	10.1	2	62	70	0.2	5.0	5.6
URT330	7.5	2.8	TR	.4	10.7	7.9	1.0	18.6	15.9	11.7	9	58	67	0.1	4.7	5.3
URT330	5.9	2.4	TR	.4	8.7	8.8	2.2	17.6	16.4	10.9	20	49	53	0.1	4.5	5.1
URT330	5.1	2.0	TR	.3	7.4	9.6	3.8	17.0	15.7	11.2	34	44	47	0.1	4.2	4.7
URT330	1.7	.8	.1	.1	2.7	3.5	1.2	6.2	5.4	3.9	31	44	50	0.1	4.2	4.8
URT330	1.9	.8	TR	.2	2.9	5.3	1.6	8.2	7.3	4.5	36	35	40	0.1	4.3	5.0
URT330	2.4	1.2	TR	.2	3.8	6.0	2.1	9.8	9.2	5.9	36	39	41	0.1	4.3	4.9
URT330	2.2	.8	0.0	.2	3.2	5.0	1.4	8.2	7.5	4.6	30	39	43	0.1	4.3	5.0
URT330	2.0	.8	0.0	.1	2.9	3.1	.4	6.0	5.6	3.3	12	48	52	0.1	4.5	5.1

m/lcu13

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	-----TOTAL------ CLAY < .002	SILT .002 -.05	SAND .05 -2	---SILT---- FINE .002 -.02	COARSE .02 -.05	------------SAND------------ VF .05 -.10	F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	>VF .10 -2	TEXT CLASS
				---------------------% of < 2mm											
URT380	0-10	0-4		11.8	52.0	36.3	27.9	24.1	6.7	17.9	6.7	3.3	1.7	29.5	SIL
URT380	10-20	4-8		16.4	54.8	28.8	31.8	23.0	5.9	14.2	5.3	2.4	0.9	22.9	SIL
URT380	20-30	8-12		20.1	54.8	25.1	32.3	22.5	5.6	12.5	4.2	1.9	0.9	19.5	SIL
URT380	30-46	12-18		26.2	50.6	23.2	29.5	21.1	5.4	11.4	3.6	1.8	1.1	17.8	SIL
URT380	46-56	18-22		23.9	51.9	24.2	29.2	22.7	6.1	11.7	3.4	1.8	1.1	18.0	SIL
URT380	56-66	22-26		22.4	52.6	24.9	29.0	23.7	6.5	12.6	3.4	1.5	1.0	18.5	SIL
URT380	66-76	26-30		22.4	53.1	24.5	30.1	23.0	6.8	12.4	3.1	1.4	0.8	17.6	SIL
URT380	76-89	30-35		23.9	52.9	23.3	30.1	22.7	6.3	11.8	2.8	1.1	1.2	16.9	SIL
URT380	89-97	35-38		23.5	49.0	27.4	28.6	20.4	6.2	14.0	3.7	1.2	2.4	21.3	L
URT380	97-107	38-42		26.9	47.5	25.6	27.1	20.4	6.7	14.0	2.9	0.9	1.1	18.9	L
URT380	107-122	42-48		26.8	47.2	26.0	28.7	18.5	5.8	13.4	4.0	1.7	1.1	20.2	L
URT380	122-142	48-56		35.0	19.6	45.4	12.8	6.8	1.6	8.8	9.2	9.3	16.5	43.8	SCL
URT380	142-152	56-60		30.0	8.7	61.3	5.1	3.6	1.0	7.2	14.2	18.2	20.6	60.3	SCL
URT380	152-168	60-66		23.8	4.7	71.5	1.8	2.9	0.6	7.6	22.0	25.1	16.2	70.9	SCL
URT3110	0-20	0-8		10.7	53.9	35.5	27.4	26.4	7.3	18.1	6.3	2.7	1.0	28.2	SIL
URT3110	20-36	8-14		15.3	57.4	27.2	33.5	24.0	5.7	13.7	4.9	2.2	0.7	21.5	SIL
URT3110	36-51	14-20		19.9	54.7	25.4	31.4	23.3	5.5	12.5	4.3	2.1	1.0	19.9	SIL
URT3110	51-66	20-26		26.4	48.1	25.6	28.2	19.9	5.5	12.0	4.0	2.3	1.8	20.0	L
URT3110	66-91	26-36		24.6	46.7	28.7	26.5	20.2	5.4	11.3	4.0	2.7	5.2	23.2	L
URT3110	91-122	36-48		33.2	28.3	38.5	17.1	11.2	1.8	4.6	3.3	6.3	22.5	36.7	CL
URT3110	122-152	48-60		24.9	33.4	41.6	20.6	12.8	2.7	7.5	7.1	8.6	15.7	38.9	L

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	------CEC------ SUM CATS	NH4 OAc	BASES +Al	Al SAT	BASE SAT SUM	NH4 OAc	ORG C	---pH---- CaCl2 .01M	H2O
	-----------------------------	-meq/100 g-	---------	---------	---------	---------	---------	---------	---------	-------------	---------	---%---	---------	---------		
URT380	2.4	.4	0.0	.1	2.9	5.5	.2	8.3	7.0	3.1	6	35	41	0.9	5.0	5.6
URT380	2.6	.8	TR	.2	3.6	5.1	.2	8.7	7.2	3.8	5	41	50	0.4	5.2	5.7
URT380	3.9	.8	0.0	.2	4.9	5.2	.2	10.1	8.8	5.1	4	49	55	0.3	5.1	5.6
URT380	5.8	1.2	TR	.2	7.2	5.5	.3	12.7	11.8	7.5	4	57	61	0.2	5.1	5.6
URT380	4.9	1.2	TR	.2	6.3	5.3	.5	11.6	11.2	6.8	7	54	56	0.1	4.9	5.6
URT380	3.1	.8	TR	.2	4.1	7.0	2.0	11.1	9.5	6.1	33	37	43	0.1	4.5	5.3
URT380	1.9	.8	TR	.1	2.8	7.2	2.9	10.0	8.3	5.7	51	28	33	0.1	4.2	5.0
URT380	2.4	.8	.1	.2	3.5	7.8	3.9	11.3	9.2	7.4	53	31	38	0.1	4.2	5.0
URT380	1.2	.8	.1	.2	2.3	8.1	4.1	10.4	8.8	6.4	64	22	26	0.1	4.1	4.9
URT380	1.2	.8	TR	.2	2.2	9.3	5.2	11.5	9.3	7.4	70	19	24	0.1	4.0	4.9
URT380	.7	.8	TR	.2	1.7	9.8	5.4	11.5	11.2	7.1	76	15	15	0.1	3.9	4.7
URT380	1.0	1.2	TR	.2	2.4	12.5	7.0	14.9	13.1	9.3	74	16	18	0.1	3.9	4.5
URT380	.9	1.6	.1	.2	2.8	10.3	5.8	13.1	12.6	8.6	67	21	22	0.1	3.9	4.6
URT380	.7	1.1	.1	.2	2.1	9.1	4.6	11.2	9.3	6.7	69	19	22	0.1	4.0	4.8
URT3110	2.3	.8	TR	.1	3.2	5.7	.3	8.8	7.0	3.5	9	36	46	0.9	4.7	5.4
URT3110	3.3	.4	TR	.2	3.9	5.6	.4	9.5	7.3	4.3	9	41	53	0.6	4.7	5.4
URT3110	4.4	.8	TR	.2	5.4	5.0	.5	10.4	8.8	5.9	8	52	61	0.4	4.8	5.5
URT3110	5.8	1.5	TR	.2	7.5	5.4	.3	12.9	11.4	7.8	4	58	66	0.3	4.9	5.6
URT3110	4.3	1.6	TR	.2	6.1	5.7	.9	11.8	10.8	7.0	13	52	56	0.2	4.6	5.4
URT3110	4.3	2.0	TR	.2	6.5	7.7	1.7	14.2	12.7	8.2	21	46	51	0.1	4.5	5.3
URT3110	4.4	1.9	TR	.2	6.5	5.3	.5	11.8	10.2	7.0	7	55	64	0.1	4.8	5.5

mflw14

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
URT3X130	0-13	0-5		11.8	51.9	36.3	25.3	26.5	6.8	17.8	6.9	3.4	1.4	29.5	SIL
URT3X130	13-25	5-10		11.1	54.3	34.6	29.5	24.8	6.8	17.3	6.3	2.8	1.4	27.8	SIL
URT3X130	25-43	10-17		13.6	59.9	26.5	35.4	24.5	5.5	12.7	4.9	2.3	0.9	21.0	SIL
URT3X130	43-66	17-26		18.2	57.0	24.8	34.0	23.0	5.0	12.2	4.7	2.2	0.7	19.8	SIL
URT3X130	66-84	26-33		23.3	51.3	25.3	31.1	20.2	4.7	11.5	4.4	2.7	2.1	20.6	SIL
URT3X130	84-99	33-39		24.5	47.3	28.2	27.5	19.8	5.5	12.3	4.6	2.9	2.9	22.8	L
URT3X130	99-122	39-48		21.5	46.2	32.3	26.5	19.7	5.6	13.2	6.1	4.0	3.4	26.7	L
URT3X130	122-142	48-56		22.8	37.4	39.8	22.4	15.0	4.5	13.6	7.8	5.7	8.2	35.3	L
URT3X130	142-163	56-64		23.6	33.7	42.7	19.7	14.0	4.8	16.2	9.6	6.9	5.1	37.9	L
URT3EX170	0-10	0-4		14.4	68.1	17.5	39.1	29.0	4.3	7.9	3.2	1.3	0.7	13.2	SIL
URT3EX170	10-23	4-9		11.0	67.9	21.1	39.4	28.5	4.7	9.8	4.0	1.9	0.6	16.4	SIL
URT3EX170	23-36	9-14		11.7	66.1	22.2	39.7	26.4	4.8	10.8	4.1	1.9	0.5	17.3	SIL
URT3EX170	36-48	14-19		13.3	69.0	17.7	46.1	22.9	4.7	8.0	3.1	1.3	0.5	12.9	SIL
URT3EX170	48-56	19-22		15.7	66.7	17.6	42.8	23.8	4.7	8.4	3.2	1.1	0.3	12.9	SIL
URT3EX170	56-69	22-27		16.7	64.3	19.0	41.2	23.1	5.0	8.7	3.6	1.2	0.5	14.0	SIL
URT3EX170	69-79	27-31		18.0	62.4	19.5	37.4	25.0	4.7	8.9	4.0	1.4	0.4	14.8	SIL
URT3EX170	79-86	31-34		18.9	60.0	21.1	37.2	22.9	4.6	9.2	4.8	1.9	0.6	16.4	SIL
URT3EX170	86-102	34-40		19.7	57.7	22.6	34.6	23.1	4.4	9.9	5.7	2.1	0.5	18.3	SIL
URT3EX170	102-119	40-47		22.3	51.3	26.4	31.2	20.1	3.5	10.5	7.9	3.4	1.0	22.9	SIL
URT3EX170	119-137	47-54		24.0	52.5	23.5	32.8	19.7	3.1	9.8	6.8	2.9	0.7	20.3	SIL
URT3EX170	137-152	54-60		27.2	54.3	18.5	34.9	19.5	3.0	8.2	4.3	2.3	0.6	15.4	SICL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	NH4 OAc	BASES +Al	Al SAT	BASE SAT SUM	NH4 OAc	ORG C	pH CaCl2 .01M	H2O
	---meq/100 g---										---%---					
URT3X130	4.0	1.2	0.0	.3	5.5	4.8	0.0	10.3	8.3	5.5	0	53	66	1.3	5.2	6.0
URT3X130	1.9	.8	0.0	.2	2.9	5.6	.4	8.5	6.4	3.3	12	34	45	0.6	4.6	5.3
URT3X130	3.3	.4	TR	.1	3.8	5.5	.4	9.3	6.6	4.2	10	41	58	0.5	4.6	5.4
URT3X130	3.3	.8	TR	.2	4.3	5.2	.4	9.5	7.8	4.7	9	45	55	0.4	4.7	5.4
URT3X130	4.6	1.5	TR	.2	6.3	5.9	.4	12.2	11.5	6.7	6	52	55	0.2	4.8	5.5
URT3X130	3.5	1.6	TR	.2	5.3	7.0	1.1	12.3	10.3	6.4	17	43	51	0.2	4.6	5.4
URT3X130	1.4	1.2	.1	.1	2.8	8.2	2.9	11.0	8.3	5.7	51	25	33	0.1	4.1	5.0
URT3X130	1.2	1.2	0.0	.1	2.5	6.8	2.9	9.3	9.3	5.4	54	27	27	0.1	4.2	5.0
URT3X130	1.4	1.2	0.0	.2	2.8	7.2	3.1	10.0	10.2	5.9	53	28	27	0.1	4.1	5.0
URT3EX170	7.6	1.6	0.0	.3	9.5	5.7	--	15.2	13.4	--	--	63	71	2.1	5.7	6.2
URT3EX170	3.1	.8	0.0	.1	4.0	4.9	--	8.8	7.2	--	--	45	56	0.7	5.1	5.8
URT3EX170	2.9	.4	0.0	.1	3.4	5.5	--	8.8	7.2	--	--	38	47	0.6	4.8	5.6
URT3EX170	5.5	.8	.1	.2	6.6	8.1	--	14.7	11.5	--	--	45	57	1.1	4.8	5.5
URT3EX170	5.1	.4	.1	.2	5.8	5.9	--	11.7	9.6	--	--	50	60	0.8	4.9	5.7
URT3EX170	4.8	.4	TR	.2	5.4	5.0	--	10.4	8.8	--	--	52	61	0.6	5.0	5.7
URT3EX170	4.7	.4	.1	.2	5.4	4.8	--	10.2	8.3	--	--	53	65	0.5	5.0	5.7
URT3EX170	4.4	.4	.1	.2	5.1	4.4	--	9.5	8.1	--	--	54	63	0.4	5.0	5.7
URT3EX170	4.5	.4	.2	.2	5.3	4.3	--	9.6	8.2	--	--	55	65	0.3	5.0	5.7
URT3EX170	4.9	.8	.1	.2	6.0	4.4	--	10.4	9.1	--	--	58	66	0.3	5.0	5.8
URT3EX170	5.7	1.6	TR	.2	7.5	4.8	--	12.3	11.1	--	--	61	68	0.2	5.1	5.8
URT3EX170	6.8	2.3	.1	.3	9.5	5.7	--	15.2	13.1	--	--	63	73	0.3	5.1	5.8

mflw15

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL			SILT		SAND						TEXT CLASS
				CLAY < .002	SILT .002 -.05	SAND .05 -2	FINE .002 -.02	COARSE .02 -.05	VF .05 -.10	F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	>VF .10 -2	
				% of < 2mm											
URT45	0-15	0-6		16.7	60.2	23.1	33.8	26.4	6.4	12.2	3.7	0.7	0.2	16.7	SIL
URT45	15-25	6-10		18.4	52.0	29.6	29.1	22.9	7.2	15.8	5.3	1.1	0.2	22.4	SIL
URT45	25-38	10-15		19.7	49.7	30.6	27.2	22.4	7.2	17.1	5.1	1.0	0.2	23.4	L
URT45	38-53	15-21		20.3	48.3	31.4	26.4	21.9	6.9	17.6	5.6	1.1	0.1	24.5	L
URT45	53-69	21-27		19.3	44.5	36.2	24.5	20.0	6.7	19.9	7.8	1.6	0.2	29.5	L
URT45	69-81	27-32		17.3	37.4	45.3	21.1	16.3	6.3	24.9	11.4	2.5	0.2	39.1	L
URT45	81-94	32-37		17.6	39.6	42.7	24.4	15.3	5.6	22.0	11.7	3.0	0.5	37.2	L
URT45	94-107	37-42		19.3	42.1	38.5	27.7	14.4	4.3	17.7	11.1	3.8	1.6	34.2	L
URT45	107-122	42-48		21.2	46.0	32.8	30.9	15.1	3.8	14.4	10.0	3.5	1.2	29.0	L
URT45	122-137	48-54		23.0	49.1	27.9	34.2	14.9	3.7	12.9	7.8	3.1	0.4	24.2	L
URT45	137-152	54-60		21.6	49.8	28.6	34.6	15.2	3.8	14.4	6.7	2.3	1.4	24.8	L
URT430	0-15	0-6		19.7	61.3	19.0	36.0	25.3	5.2	9.1	3.5	0.9	0.2	13.8	SIL
URT430	15-33	6-13		17.7	58.4	24.0	36.1	22.3	5.9	11.9	4.6	1.2	0.3	18.0	SIL
URT430	33-53	13-21		20.6	54.4	25.0	32.9	21.6	5.4	12.8	5.3	1.3	0.1	19.6	SIL
URT430	53-71	21-28		22.3	52.8	25.0	31.9	20.8	5.6	12.8	4.9	1.3	0.4	19.3	SIL
URT430	71-99	28-39		22.2	52.7	25.0	31.7	21.1	5.6	13.1	4.9	1.2	0.2	19.5	SIL
URT430	99-124	39-49		22.7	53.1	24.2	31.8	21.3	5.8	12.5	4.5	1.1	0.3	18.3	SIL
URT430	124-157	49-62		22.3	56.2	21.5	33.6	22.6	5.2	10.6	4.2	1.3	0.3	16.3	SIL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	------CEC------ SUM CATS	NH4 OAc	BASES +Al	Al SAT	BASE SAT SUM	NH4 OAc	ORG C	---pH---- CaC12 .01M	H2O
	--------------------------	meq/100 g	--------------------								---------%--------					
URT45	5.5	.8	TR	.2	6.5	5.0	0.0	11.5	10.7	6.5	0	57	61	1.2	5.6	6.2
URT45	4.9	1.5	TR	.1	6.5	5.0	0.0	11.5	9.6	6.5	0	57	68	0.5	5.2	5.8
URT45	5.0	1.6	TR	.2	6.8	4.7	0.0	11.5	9.8	6.8	0	59	69	0.4	5.2	5.8
URT45	5.1	1.5	.1	.2	6.9	4.5	0.0	11.4	9.7	6.9	0	61	71	0.4	5.2	5.9
URT45	4.3	1.6	TR	.2	6.1	4.6	.1	10.7	8.8	6.2	2	57	69	0.3	5.2	5.9
URT45	2.9	1.6	.1	.2	4.8	4.4	.4	9.2	7.9	5.2	8	52	61	0.2	4.9	5.6
URT45	2.9	1.6	.1	.2	4.8	4.8	.5	9.6	8.3	5.3	9	50	58	0.3	4.7	5.5
URT45	3.3	1.6	.1	.2	5.2	5.2	.7	10.4	8.6	5.9	12	50	60	0.3	4.7	5.4
URT45	3.5	1.5	TR	.2	5.2	6.1	.9	11.3	9.3	6.1	15	46	56	0.3	4.6	5.3
URT45	3.1	1.6	.3	.2	5.2	7.2	1.4	12.4	10.2	6.6	21	42	51	0.3	4.5	5.3
URT45	2.6	1.6	.1	.2	4.5	6.7	1.4	11.2	9.8	5.9	24	40	45	0.3	4.4	5.2
URT430	7.2	2.8	TR	.4	10.4	5.6	--	16.0	14.3	--	--	65	73	1.8	5.8	6.3
URT430	8.6	2.3	TR	.2	11.1	4.5	--	15.6	11.9	--	--	71	93	0.9	5.8	6.4
URT430	6.1	1.9	0.0	.2	8.2	4.1	--	12.3	10.9	--	--	67	75	0.5	5.6	6.3
URT430	6.4	2.0	TR	.2	8.6	4.6	--	13.2	11.6	--	--	65	74	0.5	5.9	6.5
URT430	6.7	2.4	0.0	.2	9.3	4.4	--	13.7	11.7	--	--	68	79	0.4	5.9	6.5
URT430	6.4	2.7	TR	.2	9.3	4.8	--	14.1	12.5	--	--	66	74	0.4	5.9	6.5
URT430	6.0	2.8	TR	.2	9.0	4.8	--	13.8	12.3	--	--	65	73	0.3	5.7	6.4

mf/ev:6

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	-----TOTAL------ CLAY < .002	SILT .002 -.05	SAND .05 -2	---SILT---- FINE .002 -.02	COARSE .02 -.05	------------SAND------------ VF .05 -.10	F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	>VF .10 -2	TEXT CLASS
				----------------------% of < 2mm											
URT480	0-10	0-4		20.1	55.7	24.2	33.3	22.5	5.4	10.4	5.6	2.2	0.5	18.8	SIL
URT480	10-20	4-8		15.5	50.6	33.9	31.0	19.6	5.6	13.7	8.1	4.0	2.5	28.3	SIL
URT480	20-36	8-14		15.5	40.8	43.6	24.1	16.8	5.1	18.8	12.6	5.4	1.7	38.5	L
URT480	36-56	14-22		16.6	41.4	42.0	24.5	16.9	5.4	21.0	11.6	3.6	0.5	36.6	L
URT480	56-74	22-29		18.5	45.0	36.5	26.1	18.9	6.3	19.5	8.4	2.0	0.2	30.1	L
URT480	74-86	29-34		19.6	45.8	34.7	27.0	18.8	6.3	18.3	7.9	2.0	0.2	28.4	L
URT480	86-107	34-42		20.3	43.3	36.4	24.7	18.6	6.1	18.5	8.6	2.7	0.5	30.3	L
URT480	107-127	42-50		22.7	50.1	27.2	29.0	21.2	7.1	13.8	4.8	1.4	0.1	20.1	SIL
URT480	127-140	50-55		23.2	56.6	20.2	33.0	23.6	7.7	10.0	2.1	0.5	0.0	12.5	SIL
URT480	140-152	55-60		24.1	56.7	19.2	32.5	24.3	7.4	9.7	1.7	0.4	0.0	11.8	SIL
URT480	152-173	60-68		20.6	50.2	29.2	28.5	21.7	7.4	14.5	5.5	1.6	0.3	21.8	SIL
URT4125	0-10	0-4		17.9	49.2	32.9	28.8	20.4	5.2	11.8	9.4	4.8	1.7	27.7	L
URT4125	10-20	4-8		12.3	33.9	53.8	19.4	14.5	4.6	18.4	16.5	9.0	5.2	49.2	MSL
URT4125	20-46	8-18		13.6	33.0	53.4	19.7	13.3	4.2	19.5	17.9	8.9	3.0	49.2	FSL
URT4125	46-71	18-28		12.7	28.9	58.3	17.0	12.0	3.5	19.6	22.0	10.5	2.8	54.8	MSL
URT4125	71-81	28-32		11.1	24.1	64.8	13.6	10.5	3.4	21.0	25.7	12.1	2.7	61.5	MSL
URT4125	81-91	32-36		8.7	18.9	72.4	10.7	8.2	2.8	20.2	28.4	15.8	5.2	69.6	MSL
URT4125	91-122	36-48		2.8	9.5	87.7	5.9	3.6	2.4	29.5	39.4	14.3	2.1	85.3	S
URT4125	122-137	48-54		17.0	41.4	41.7	24.2	17.2	6.4	24.4	8.7	1.9	0.3	35.3	L
URT4125	137-152	54-60		18.5	45.0	36.5	26.7	18.3	6.9	21.9	6.4	1.1	0.2	29.6	L

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	------CEC------ SUM CATS	NH4 OAc	BASES +Al	Al SAT	BASE SAT SUM	NH4 OAc	ORG C	---pH---- CaCl2 .01M	H2O
	-----------------------------	-meq/100 g	------	-----------	------	------	-----				---------	-%------	-----			
URT480	14.7	3.6	TR	.2	18.5	5.9	--	24.4	20.4	--	--	76	91	3.2	6.4	6.8
URT480	9.5	2.7	TR	.2	12.4	4.4	--	16.8	14.1	--	--	74	88	1.5	6.7	7.2
URT480	5.8	2.4	0.0	.1	8.3	3.6	--	11.9	10.0	--	--	70	83	0.7	6.7	7.2
URT480	5.3	2.0	0.0	.2	7.5	3.8	--	11.3	9.8	--	--	66	76	0.4	6.5	7.2
URT480	5.5	2.0	0.0	.2	7.7	4.4	--	12.1	10.6	--	--	64	73	0.4	6.4	6.9
URT480	5.4	2.3	0.0	.2	7.9	4.2	--	12.1	11.0	--	--	65	72	0.3	6.1	6.8
URT480	5.3	2.4	0.0	.2	7.9	4.0	--	11.9	10.7	--	--	66	74	0.4	5.5	6.2
URT480	5.7	2.8	TR	.2	8.7	4.7	--	13.4	12.1	--	--	65	72	0.4	5.6	6.2
URT480	5.9	3.5	0.0	.2	9.6	4.8	--	14.4	13.1	--	--	67	73	0.5	5.5	6.2
URT480	5.6	3.6	TR	.2	9.3	5.1	--	14.5	12.6	--	--	65	75	0.4	5.5	6.2
URT480	4.5	3.5	TR	.2	8.2	5.0	--	13.2	11.2	--	--	62	73	0.4	5.4	6.1
URT4125	13.7	3.5	0.0	.4	17.6	5.5	--	23.1	18.2	--	--	76	97	2.8	6.6	7.1
URT4125	6.8	2.0	0.0	.1	8.8	3.5	--	12.4	10.3	--	--	72	86	1.0	6.5	7.0
URT4125	5.0	2.0	0.0	.2	7.2	3.1	--	10.3	9.2	--	--	70	78	0.6	6.8	7.3
URT4125	3.3	1.6	0.0	.2	5.1	2.9	--	8.0	7.4	--	--	64	69	0.2	6.2	6.9
URT4125	2.9	1.6	0.0	.1	4.6	2.4	--	7.0	6.4	--	--	66	72	0.2	6.2	6.9
URT4125	2.4	1.2	0.0	.1	3.7	2.1	--	5.8	5.4	--	--	64	69	0.2	6.1	6.8
URT4125	.7	.4	.1	.1	1.3	1.2	--	2.5	2.6	--	--	52	50	0.1	5.6	6.4
URT4125	4.8	2.4	TR	.2	7.4	3.6	--	11.0	10.1	--	--	67	73	0.4	5.8	6.5
URT4125	5.2	2.7	TR	.2	8.1	4.0	--	12.1	10.8	--	--	67	75	0.4	5.8	6.4

n.l/~17

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL: CLAY < .002	TOTAL: SILT .002 -.05	TOTAL: SAND .05 -2	SILT: FINE .002 -.02	SILT: COARSE .02 -.05	SAND: VF .05 -.10	SAND: F .10 -.25	SAND: M .25 -.50	SAND: C .5 -1	SAND: VC 1 -2	SAND: >VF .10 -2	TEXT CLASS
				% of < 2mm											
URT510	0-15	0-6		16.4	47.0	36.6	25.0	22.0	6.5	17.5	8.1	3.1	1.4	30.1	L
URT510	15-30	6-12		12.4	35.3	52.3	18.5	16.8	4.9	15.5	12.7	8.6	10.5	47.3	MSL
URT510	30-41	12-16		11.7	34.4	53.9	18.8	15.6	5.4	20.8	15.6	7.0	5.2	48.6	FSL
URT510	41-51	16-20		11.7	34.4	53.9	18.8	15.6	5.6	24.4	16.2	4.5	3.3	48.3	FSL
GRAV.LAYR	41-61	16-24		5.1	7.2	87.7	3.5	3.6	1.3	8.1	7.8	7.9	62.6	86.4	COS
URT510	51-61	20-24		10.8	35.5	53.7	18.9	16.7	6.8	23.7	12.9	4.5	5.8	46.9	FSL
URT510	61-76	24-30		8.1	26.3	65.6	13.8	12.5	5.5	24.3	19.4	9.2	7.1	60.1	MSL
URT510	76-91	30-36		8.0	23.6	68.5	12.7	10.9	4.1	27.3	24.2	10.1	2.7	64.4	MSL
URT510	91-102	36-40		11.6	24.0	64.4	13.3	10.7	4.0	29.0	22.8	7.0	1.5	60.4	MSL
URT510	102-112	40-44		11.8	23.8	64.4	13.0	10.8	3.9	29.6	23.2	6.6	1.0	60.5	MSL
URT510	112-122	44-48		11.8	21.6	66.6	11.5	10.0	4.0	30.1	24.4	6.9	1.3	62.6	FSL
URT510	122-132	48-52		10.6	21.2	68.2	11.2	10.0	3.8	28.9	26.0	8.0	1.5	64.4	MSL
URT510	132-142	52-56		12.7	25.7	61.6	13.9	11.8	4.8	27.9	21.8	6.0	1.3	56.9	FSL
URT510	142-152	56-60		12.9	30.2	56.9	16.4	13.8	5.2	26.9	18.9	5.0	0.9	51.6	FSL

SAMPLE #	NH4OAc EXTRACTABLE BASES: Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC: SUM CATS	CEC: NH4 OAc	CEC: BASES +Al	Al SAT	BASE SAT: SUM	BASE SAT: NH4 OAc	ORG C	pH: CaCl2 .01M	pH: H2O
	meq/100 g										%					
URT510	11.0	3.2	TR	.3	14.5	5.0	--	19.5	16.8	--	--	74	86	2.3	6.0	6.5
URT510	6.4	1.9	0.0	.2	8.5	3.5	--	12.0	10.2	--	--	71	83	1.1	5.9	6.7
URT510	5.9	1.9	0.0	.2	8.0	3.5	--	11.5	10.3	--	--	70	78	1.0	5.8	6.6
URT510	5.8	2.0	0.0	.1	7.9	3.7	--	11.6	10.3	--	--	68	77	0.8	5.8	6.6
URT510	2.1	.8	.1	.1	3.1	1.8	--	4.9	4.4	--	--	63	70	0.3	5.7	6.5
URT510	4.0	1.5	TR	.1	5.6	2.7	--	8.3	8.0	--	--	67	70	0.6	5.8	6.6
URT510	2.2	1.2	.2	.1	3.7	2.0	--	5.7	5.1	--	--	65	73	0.3	5.8	6.5
URT510	1.9	1.2	0.0	.1	3.2	2.0	--	5.2	4.7	--	--	62	68	0.2	5.7	6.6
URT510	3.2	1.6	0.0	.3	5.1	2.5	--	7.6	6.6	--	--	67	77	0.2	6.1	6.8
URT510	3.6	1.6	.3	.4	5.9	2.5	--	8.3	6.7	--	--	70	88	0.2	6.0	6.8
URT510	3.3	1.6	.2	.3	5.4	2.3	--	7.7	6.3	--	--	70	86	0.2	5.8	6.6
URT510	2.4	1.2	0.0	.1	3.7	2.3	--	6.0	5.8	--	--	62	64	0.2	5.7	6.6
URT510	3.1	1.6	.1	.1	4.9	2.7	--	7.6	7.0	--	--	64	70	0.1	5.8	6.6
URT510	3.9	1.5	.2	.4	6.0	3.1	--	9.1	7.5	--	--	66	80	0.3	5.6	6.5

mfl/w11D

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
URT580	0-15	0-6		6.2	13.9	79.9	8.0	5.8	1.6	8.5	17.8	17.9	34.2	78.4	LCOS
URT580	15-30	6-12		9.8	30.9	59.3	19.5	11.4	2.9	12.8	18.3	13.1	12.3	56.4	COSL
URT580	30-46	12-18		13.2	36.2	50.6	21.6	14.6	3.9	15.3	14.9	8.5	8.0	46.7	L
URT580	46-61	18-24		15.3	44.3	40.4	29.5	14.9	3.0	10.8	10.2	6.8	9.6	37.4	L
URT580	61-76	24-30		4.8	9.2	85.9	5.9	3.3	0.6	8.8	19.9	19.5	37.2	85.4	LCOS
URT580	76-91	30-36		14.6	44.0	41.5	26.4	17.6	5.9	21.1	10.8	3.0	0.7	35.6	L
URT580	91-102	36-40		7.0	15.7	77.3	9.3	6.3	2.9	26.8	31.5	12.6	3.6	74.5	LS
URT580	102-117	40-46		6.9	12.6	80.5	7.0	5.6	2.6	27.7	36.4	12.4	1.4	77.9	LS
URT580	117-132	46-52		7.1	15.2	77.7	8.8	6.4	3.3	28.2	34.8	10.3	1.1	74.5	LS
URT580	132-147	52-58		14.9	34.8	50.3	19.9	14.9	8.0	31.5	9.0	1.4	0.3	42.3	L
URT580	147-163	58-64		18.6	48.4	33.0	28.6	19.8	6.9	18.2	6.2	1.2	0.5	26.1	L
URT620	0-10	0-4		11.8	54.4	33.8	34.8	19.6	3.0	14.1	9.6	4.1	2.9	30.8	SIL
URT620	10-18	4-7		12.8	55.9	31.3	37.4	18.5	2.8	13.8	9.4	3.6	1.6	28.4	SIL
URT620	18-25	7-10		17.1	59.3	23.6	40.0	19.3	2.5	10.2	6.6	2.5	1.9	21.1	SIL
URT620	25-36	10-14		20.9	54.2	24.9	38.0	16.2	2.2	9.2	5.9	2.9	4.6	22.6	SIL
URT620	36-51	14-20		23.5	41.1	35.4	26.5	14.6	2.9	11.0	6.7	4.4	10.4	32.5	L
URT620	51-66	20-26		19.6	45.3	35.2	28.0	17.3	3.3	13.4	7.3	3.7	7.6	31.9	L
URT620	66-81	26-32		23.3	39.7	37.1	24.8	14.9	2.7	10.9	7.0	4.1	12.2	34.3	L
URT620	81-97	32-38		30.4	38.8	30.8	24.9	13.9	2.4	10.6	6.4	3.3	8.2	28.4	CL
URT620	97-112	38-44		31.1	42.4	26.5	28.4	14.0	2.1	9.3	5.5	2.9	6.7	24.4	CL
URT620	112-127	44-50		34.2	38.0	27.7	23.9	14.2	2.6	11.8	6.8	3.0	3.5	25.1	CL
URT620	127-152	50-60		41.4	34.8	23.9	21.5	13.3	2.5	10.7	6.6	2.8	1.2	21.4	C

SAMPLE #	NH4OAc EXTRACTABLE BASES					ACID-ITY	EXTR Al	------CEC------			Al SAT	BASE SAT		ORG C	---pH----	
	Ca	Mg	Na	K	SUM BASES			SUM CATS	NH4 OAc	BASES +Al		SUM	NH4 OAc		CaCl2 .01M	H2O
	--------------------------meq/100 g-----------------										---------%--------					
URT580	5.9	1.6	0.0	.2	7.7	2.4	--	10.1	8.0	--	--	76	96	1.4	6.6	7.3
URT580	6.9	2.0	0.0	.1	9.0	3.0	--	12.0	10.5	--	--	75	86	1.2	6.4	7.0
URT580	6.6	2.0	0.0	.1	8.7	3.7	--	12.4	10.3	--	--	70	84	0.9	6.4	7.0
URT580	7.0	2.4	0.0	.1	9.5	4.1	--	13.6	12.1	--	--	70	79	1.2	6.2	6.9
URT580	2.7	.8	0.0	TR	3.6	1.7	--	5.3	4.5	--	--	68	80	0.3	6.2	7.0
URT580	7.2	2.0	TR	.1	9.3	4.2	--	13.5	12.0	--	--	69	78	1.0	6.1	6.8
URT580	3.6	1.2	TR	TR	4.9	2.1	--	7.0	5.9	--	--	70	83	0.4	5.9	6.7
URT580	3.2	1.2	0.0	TR	4.5	1.8	--	6.3	5.5	--	--	71	82	0.3	5.9	6.7
URT580	3.3	1.2	0.0	TR	4.5	1.9	--	6.4	5.7	--	--	70	79	0.3	5.9	6.7
URT580	6.1	2.4	0.0	.1	8.6	3.7	--	12.3	10.6	--	--	70	81	0.6	6.0	6.7
URT580	9.3	3.5	0.0	.1	12.9	4.9	--	17.8	15.2	--	--	72	85	1.2	5.9	6.7
URT620	6.5	.8	TR	.3	7.6	5.0	--	12.6	10.3	--	--	60	74	1.7	5.8	6.4
URT620	4.4	.8	0.0	.2	5.4	4.1	--	9.5	7.7	--	--	57	70	0.5	5.9	6.6
URT620	5.0	.8	0.0	.2	6.0	4.0	--	10.0	8.2	--	--	60	73	0.4	6.0	6.8
URT620	6.3	.8	TR	.3	7.4	4.2	--	11.6	9.8	--	--	64	76	0.3	5.9	6.6
URT620	7.7	1.1	0.0	.3	9.1	4.6	--	13.7	11.1	--	--	66	82	0.2	5.7	6.4
URT620	6.0	.8	0.0	.2	7.0	3.8	--	10.8	9.5	--	--	65	74	0.1	5.7	6.3
URT620	6.1	1.2	0.0	.3	7.6	4.0	--	11.6	10.5	--	--	66	72	0.1	5.6	6.3
URT620	6.5	2.0	0.0	.5	9.0	4.8	--	13.8	11.5	--	--	65	78	0.1	5.8	6.4
URT620	6.4	2.3	0.0	.6	9.3	4.9	--	14.2	13.1	--	--	65	71	0.1	5.9	6.5
URT620	6.5	2.7	TR	.9	10.1	5.2	--	15.3	12.8	--	--	66	79	0.1	5.8	6.4
URT620	7.8	2.7	TR	1.1	11.6	6.1	--	17.7	15.0	--	--	66	77	0.1	5.9	6.5

SAMPLE	DEPTH	TOTAL WEIGHT	GRAVEL WT.	% GRAVEL
UR-T1-35	0-5	763	129	17
	5 - 9	681	16	2
	9 - 13	614	4	1
	13-16	820	15	2
	16-19	871	143	16
	19-22	643	50	8
	22-26	651	47	7
	26-30	747	73	10
	30-34	701	131	19
	34-37	897	571	64
	37-40	752	532	71
	40-44	627	263	42
	44-48	599	339	57
	48-51	625	64	10
	51-54	748	77	10
UR-T1-80	36-40	874	488	56
	40-44	880	517	59
	44-48	912	541	59
UR-T1-95	0-5	592	9	2
	5 - 9	461	4	1
	9 - 15	522	3	1
	15-20	551	4	1
	20-24	495	3	1
	24-29	640	4	1
	29-33	622	33	5
	33-37	836	19	2
	37-41	754	27	4
	41-46	744	136	18
	46-50	561	134	24
UR-T2-10	0-4	905	4	0
	4 - 7	648	4	1
	7 - 12	655	4	1
	12 - 15	691	4	1
	15-22	750	4	1
	22-27	686	4	1
	27-32	800	55	7
	32-37	906	64	7
	37-41	851	128	15
	41-44	697	150	22
	44-47	825	355	43
	47-54	935	771	82

UR-T2-50	0-6	844	56	7
	6 - 12	666	74	11
	12 - 16	806	163	20
	16-20	777	247	32
	20-24	897	483	54
	24-30	1197	843	70
	30-36	1349	975	72
	36-40	1450	1044	72
	40-44	1165	795	68
UR-T2-140	0-8	646	3	0
	8 - 16	634	4	1
	16-24	660	7	1
	24-30	813	6	1
	30-36	642	86	13
	36-44	698	242	35
	44-48	521	133	26
	48-54	783	165	21
UR-T3-30	0-6	1060	15	1
	6 - 14	787	12	2
	14-18	895	171	19
	18-22	799	109	14
	22-26	785	98	12
	26-30	724	284	39
	30-36	878	211	24
	36-42	1346	972	72
	42-48	869	362	42
	48-54	1032	196	19
	54-60	1125	762	68
	60-68	1259	904	72
UR-T3-80	0-4	795	7	1
	4 - 8	558	10	2
	8 - 12	605	3	0
	12 - 18	658	14	2
	18-22	657	25	4
	22-26	791	95	12
	26-30	720	10	1
	30-35	820	30	4
	35-38	918	459	50
	38-42	770	24	3
	42-48	918	143	16
	48-56	1100	742	67
	56-60	1020	708	69
	60-66	1045	715	68

				% gravel
UR-T3-110	0-8	725	15	2
	8 - 14	780	9	1
	14-20	958	7	1
	20-26	992	35	4
	26-36	1091	593	54
	36-48	1139	800	70
	48-60	1215	946	78
UR-T3X-130	0-5	742	12	2
	5 - 10	960	20	2
	10 - 17	746	8	1
	17-26	978	7	1
	26-33	979	46	5
	33-39	789	31	4
	39-48	1047	328	31
	48-56	1000	618	62
	56-64	762	211	28
UR-T3EX-170	0-4	712	1	0
	4 - 9	648	2	0
	9 - 14	706	3	0
	14-19	561	6	1
	19-22	554	1	0
	22-27	613	2	0
	27-31	596	0	0
	31-34	658	2	0
	34-40	750	1	0
	40-47	855	2	0
	47-54	998	4	0
	54-60	774	4	1
UR-T4-5	0-6	795	1	0
	6 - 10	1001	0	0
	10 - 15	746	0	0
	15-21	799	0	0
	21-27	812	0	0
	27-32	874	0	0
	32-37	901	0	0
	37-42	799	1	0
	42-48	861	0	0
	48-54	833	0	0
	54-60	876	2	0
UR-T4-30	0-6	594	1	0
	6 - 13	835	1	0
	13-21	893	0	0
	21-28	928	0	0
	28-39	870	0	0
	39-49	690	0	0
	49-62	895	1	0

UR-T4-80	0-4	643	0	0
	4 - 8	1069	19	2
	8 - 14	900	0	0
	14-22	742	0	0
	22-29	843	0	0
	29-34	864	6	1
	34-42	849	4	0
	42-50	900	1	0
	50-55	760	0	0
	55-60	801	1	0
	60-68	761	1	0
UR-T4-125	0-4	660	0	0
	4 - 8	858	256	30
	8 - 18	1176	86	7
	18-28	989	11	1
	28-32	927	145	16
	32-36	1048	230	22
	36-48	1125	81	7
	48-54	967	4	0
	54-60	730	0	0
UR-T5-10	0-6	859	28	3
	6 - 12	1110	717	65
	12 - 16	969	211	22
	16-20	1145	551	48
GRAVEL LAYER	16-24	1262	1074	85
	20-24	925	447	48
	24-30	1372	708	52
	30-36	1066	49	5
	36-40	1035	1	0
	40-44	821	1	0
	44-48	820	1	0
	48-52	993	1	0
	52-56	905	1	0
	56-60	735	0	0
UR-T5-80	0-6	1185	636	54
	6 - 12	817	200	24
	12 - 18	1007	312	31
	18-24	985	462	47
	24-30	979	775	79
	30-36	759	0	0
	36-40	1006	7	1
	40-46	1039	1	0
	46-52	1105	7	1
	52-58	788	0	0
	58-64	704	0	0

UR-T6-20	0-4	707	21	3
	4 - 7	804	11	1
	7 - 10	914	12	1
	10 - 14	897	240	27
	14-20	936	610	65
	20-26	982	666	68
	26-32	921	510	55
	32-38	906	496	55
	38-44	975	408	42
	44-50	880	255	29
	50-60	830	30	4

Fort Leonard Wood sample data   3-13-95   MISSOURI SOIL CHARACTERIZATION LABORATORY

[illegible] data

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
BPT4-1	0-5	0-2		17.2	59.1	23.7	36.2	22.9	4.6	12.3	5.6	0.9	0.2	19.1	SIL
BPT4-2	5-15	2-6		11.8	53.0	35.2	33.8	19.2	5.6	18.9	8.6	1.5	0.5	29.6	SIL
BPT4-3	15-23	6-9		12.8	45.9	41.3	27.8	18.1	6.3	23.1	10.0	1.8	0.1	35.0	L
BPT4-4	23-30	9-12		12.6	44.3	43.0	27.3	17.1	6.0	23.9	11.1	1.9	0.1	37.0	L
BPT4-5	30-38	12-15		12.7	43.7	43.6	27.1	16.6	5.8	24.4	11.3	2.0	0.1	37.8	L
BPT4-6	38-46	15-18		12.7	41.8	45.4	25.4	16.4	5.8	25.1	12.4	2.1	0.1	39.7	L
BPT4-7	46-53	18-21		14.0	40.3	45.7	23.9	16.4	5.9	25.7	11.8	2.1	0.1	39.8	L
BPT4-8	53-64	21-25		14.2	38.3	47.5	22.8	15.4	5.9	26.9	12.8	1.9	0.1	41.7	L
BPT4-9	64-71	25-28		14.0	37.0	48.9	22.5	14.5	5.9	27.7	13.0	2.3	0.1	43.1	L
BPT4-10	71-79	28-31		14.2	36.0	49.8	21.3	14.7	5.7	28.1	13.8	2.1	0.1	44.1	L
BPT4-11	79-86	31-34		13.6	35.4	51.0	20.6	14.8	5.9	28.3	14.2	2.5	0.1	45.1	L
BPT4-12	86-91	34-36		14.3	33.4	52.2	19.5	14.0	5.7	28.7	15.2	2.5	0.2	46.6	FSL
BPT4-13	91-99	36-39		14.5	32.1	53.4	19.3	12.9	5.3	28.9	16.0	2.9	0.3	48.1	FSL
BPT4-14	99-104	39-41		14.7	32.2	53.1	19.0	13.2	5.2	28.5	16.3	2.7	0.4	47.9	FSL
BPT4-15	104-112	41-44		14.6	31.5	53.9	18.8	12.7	4.6	27.6	18.1	3.2	0.3	49.2	FSL
BPT4-16	112-122	44-48		14.3	32.1	53.5	18.5	13.6	4.4	27.0	18.7	3.2	0.2	49.1	FSL
BPT4-17	122-130	48-51		15.2	31.6	53.2	19.3	12.3	4.1	27.0	18.5	3.3	0.4	49.1	FSL
BPT4-18	130-137	51-54		14.9	31.2	53.8	19.0	12.2	4.1	28.2	17.9	3.0	0.5	49.7	FSL
BPT4-19	137-142	54-56		15.0	32.3	52.8	18.9	13.4	4.4	29.2	16.3	2.7	0.2	48.4	FSL
BPT4-20	142-150	56-59		14.2	33.0	52.8	19.0	14.0	4.3	29.7	15.8	2.7	0.3	48.4	FSL
BPT4-21	150-157	59-62		15.1	35.9	49.0	20.6	15.3	5.1	28.7	12.9	2.2	0.1	43.9	L

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
BPT401	13.3	3.9	0.0	.3	17.5	6.4	--	23.9	19.9	--	--	73	88	3.8	6.3	6.6
BPT402	6.2	2.0	0.0	.2	8.3	5.3	--	13.7	11.2	--	--	61	75	1.6	5.9	6.3
BPT403	4.6	1.6	0.0	.1	6.3	5.2	--	11.5	9.3	--	--	55	68	1.0	5.6	6.2
BPT404	3.9	1.2	0.0	.1	5.2	5.1	--	10.3	8.3	--	--	50	62	0.8	5.5	6.1
BPT405	3.5	.8	0.0	.1	4.4	4.8	--	9.2	7.7	--	--	48	57	0.7	5.3	5.9
BPT406	3.3	.8	0.0	.1	4.2	4.3	--	8.5	6.9	--	--	49	61	0.5	5.4	6.0
BPT407	3.1	.8	0.0	.1	4.0	4.4	--	8.3	7.0	--	--	48	57	0.5	5.5	6.1
BPT408	3.2	.8	0.0	.1	4.1	3.7	--	7.8	6.1	--	--	53	67	0.4	5.6	6.2
BPT409	3.1	.8	0.0	.1	4.0	4.1	--	8.1	6.3	--	--	49	63	0.3	5.6	6.3
BPT410	3.2	.8	0.0	.1	4.1	3.8	--	7.9	5.8	--	--	52	71	0.3	5.7	6.2
BPT411	3.8	.8	TR	.1	4.7	3.8	--	8.5	5.9	--	--	55	80	0.3	5.9	6.5
BPT412	3.4	.8	TR	.1	4.3	4.1	--	8.3	6.2	--	--	51	69	0.3	5.8	6.4
BPT413	3.1	.8	.1	.1	4.1	3.9	--	8.0	6.2	--	--	51	66	0.2	5.7	6.3
BPT414	3.1	.8	TR	.1	4.0	3.7	--	7.7	6.0	--	--	52	67	0.2	5.6	6.2
BPT415	2.8	.8	TR	.1	3.7	3.6	--	7.3	5.9	--	--	51	63	0.2	5.7	6.3
BPT416	2.8	.8	TR	.1	3.7	3.5	--	7.2	6.0	--	--	51	62	0.2	5.8	6.4
BPT417	2.9	.8	TR	.1	3.8	3.7	--	7.5	6.1	--	--	51	62	0.2	5.8	6.3
BPT418	2.6	1.2	TR	.1	3.9	4.0	--	7.9	6.2	--	--	49	63	0.2	5.6	6.3
BPT419	2.8	1.2	TR	.1	4.1	3.8	--	7.9	6.2	--	--	52	66	0.2	5.9	6.5
BPT420	2.8	1.2	TR	.1	4.1	3.1	--	7.2	6.2	--	--	57	66	0.2	5.8	6.4
BPT421	2.8	1.6	.2	.1	4.7	3.0	--	7.7	6.1	--	--	61	77	0.2	5.9	6.6

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
BPT4-22	157-165	62-65		16.8	42.6	40.6	26.4	16.3	6.1	25.5	7.8	1.1	0.1	34.5	L
BPT4-23	165-173	65-68		16.6	47.0	36.4	28.0	19.0	6.1	24.8	4.9	0.5	0.1	30.3	L
BPT4-24	173-178	68-70		16.9	47.4	35.8	28.4	19.0	6.3	25.2	3.9	0.3	0.0	29.5	L
BPT4-25	178-185	70-73		16.3	50.2	33.5	29.4	20.8	6.3	24.3	2.7	0.2	0.0	27.2	SIL
BPT4-26	185-193	73-76		18.6	55.8	25.5	34.7	21.2	6.6	16.9	1.9	0.1	0.0	18.9	SIL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
22	2.8	1.6	TR	.1	4.5	3.1	--	7.6	7.2	--	--	59	63	0.2	5.8	6.6
23	3.1	1.9	TR	.1	5.1	3.5	--	8.6	7.7	--	--	59	66	0.2	6.0	6.5
24	3.3	1.6	TR	.1	5.0	3.1	--	8.1	7.8	--	--	62	64	0.2	5.7	6.3
25	3.4	2.0	.1	.1	5.6	3.4	--	9.0	7.6	--	--	62	74	0.2	5.7	6.3
26	3.3	2.0	.1	.1	5.5	3.8	--	9.3	8.6	--	--	59	64	0.2	5.5	6.2

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	-----TOTAL------ CLAY < .002	SILT .002 -.05	SAND .05 -2	---SILT---- FINE .002 -.02	COARSE .02 -.05	-------------SAND------------ VF .05 -.10	F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	>VF .10 -2	TEXT CLASS
				---------------------% of < 2mm											
BPT5-1	0-5	0-2		14.2	64.4	21.4	37.1	27.2	5.8	11.8	3.2	0.4	0.1	15.6	SIL
BPT5-2	5-15	2-6		14.9	62.8	22.3	38.2	24.6	5.9	12.8	2.8	0.4	0.4	16.4	SIL
BPT5-3	15-20	6-8		13.8	64.2	21.9	39.0	25.2	6.5	12.2	2.7	0.4	0.2	15.4	SIL
BPT5-4	20-28	8-11		14.9	65.3	19.8	39.1	26.2	6.5	11.3	1.7	0.2	0.2	13.3	SIL
BPT5-5	28-33	11-13		18.4	62.9	18.7	38.0	24.9	5.9	11.3	1.4	0.1	0.0	12.8	SIL
BPT5-6	33-41	13-16		19.4	61.6	18.9	36.5	25.1	6.0	11.4	1.4	0.1	0.1	12.9	SIL
BPT5-7	41-48	16-19		18.7	61.9	19.4	37.4	24.6	6.3	11.7	1.3	0.1	0.0	13.1	SIL
BPT5-8	48-53	19-21		19.8	60.7	19.5	36.8	24.0	6.2	11.7	1.3	0.1	0.1	13.3	SIL
BPT5-9	53-64	21-25		20.3	60.0	19.8	35.6	24.4	6.2	12.1	1.3	0.1	0.0	13.6	SIL
BPT5-10	64-71	25-28		20.3	59.7	20.0	35.2	24.5	6.3	12.3	1.3	0.1	0.0	13.7	SIL
BPT5-11	71-79	28-31		20.8	59.1	20.0	35.1	24.1	6.3	12.3	1.2	0.1	0.0	13.7	SIL
BPT5-12	79-86	31-34		20.5	59.6	19.9	35.4	24.2	6.3	12.2	1.4	0.1	0.0	13.6	SIL
BPT5-13	86-91	34-36		18.2	62.1	19.7	37.2	24.9	6.2	12.1	1.2	0.2	0.0	13.5	SIL
BPT5-14	91-99	36-39		19.2	61.5	19.4	35.6	25.9	6.2	11.7	1.4	0.1	0.0	13.2	SIL
BPT5-15	99-107	39-42		21.0	61.2	17.8	37.5	23.6	5.5	11.0	1.2	0.1	0.0	12.3	SIL
BPT5-16	107-114	42-45		20.0	62.5	17.5	37.3	25.2	5.4	10.6	1.4	0.1	0.0	12.1	SIL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	------CEC------ SUM CATS	NH4 OAc	BASES +Al	Al SAT	BASE SAT SUM	NH4 OAc	ORG C	---pH---- CaCl2 .01M	H2O
	----------------------------					meq/100 g		------------------			---------%--------					
BPT501	8.0	1.9	TR	.2	10.1	5.2	--	15.3	12.3	--	--	66	82	2.1	5.9	6.2
BPT502	4.7	1.2	.1	.1	6.1	5.6	--	11.7	9.3	--	--	52	66	1.0	5.2	5.8
BPT503	4.0	.8	TR	.1	4.9	5.1	--	10.0	8.1	--	--	49	60	0.7	5.2	5.7
BPT504	4.1	.4	.1	.1	4.7	4.5	--	9.2	7.8	--	--	51	60	0.5	5.1	5.8
BPT505	3.6	.8	0.0	.1	4.5	3.9	--	8.3	7.1	--	--	54	63	0.3	5.5	6.1
BPT506	4.0	.8	0.0	.2	5.0	3.7	--	8.7	7.6	--	--	57	66	0.3	5.4	6.0
BPT507	3.6	.8	TR	.1	4.5	3.7	--	8.2	7.8	--	--	55	58	0.3	5.4	6.0
BPT508	4.3	.8	0.0	.2	5.3	3.8	--	9.1	7.7	--	--	58	69	0.3	5.4	6.1
BPT509	4.1	.8	TR	.2	5.1	3.4	--	8.5	7.9	--	--	60	65	0.2	5.5	6.1
BPT510	4.5	1.2	TR	.2	5.9	3.5	--	9.3	8.0	--	--	63	74	0.2	5.5	6.1
BPT511	4.3	1.2	TR	.2	5.7	3.7	--	9.3	8.0	--	--	61	71	0.2	5.5	6.1
BPT512	4.3	1.2	TR	.2	5.7	4.0	--	9.7	8.1	--	--	59	70	0.2	5.5	6.0
BPT513	4.0	1.5	0.0	.2	5.7	3.9	--	9.6	7.9	--	--	59	72	0.2	5.5	6.1
BPT514	3.8	1.6	0.0	.2	5.6	3.9	--	9.5	7.7	--	--	59	73	0.2	5.4	6.1
BPT515	4.0	1.6	0.0	.2	5.8	4.8	--	10.6	8.1	--	--	55	72	0.2	5.4	6.1
BPT516	3.8	1.6	TR	.2	5.6	4.3	--	9.8	7.9	--	--	57	71	0.2	5.4	6.1

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
BPT5-17	114-122	45-48		16.3	63.5	20.2	38.3	25.1	5.8	12.6	1.5	0.1	0.0	14.3	SIL
BPT5-18	122-130	48-51		18.1	62.7	19.2	38.4	24.3	5.1	12.2	1.8	0.1	0.0	14.2	SIL
BPT5-19	130-137	51-54		19.9	61.1	19.0	38.2	22.9	4.1	12.4	2.3	0.1	0.0	14.9	SIL
BPT5-20	137-145	54-57		20.1	58.8	21.2	37.5	21.3	4.4	13.9	2.7	0.1	0.0	16.8	SIL
BPT5-21	145-152	57-60		19.0	58.0	23.0	35.1	22.9	4.4	15.3	3.0	0.2	0.0	18.6	SIL
BPT5-22	152-160	60-63		20.1	57.4	22.5	35.7	21.7	4.5	15.0	2.9	0.2	0.0	18.1	SIL
BPT5-23	160-168	63-66		20.3	59.0	20.7	36.3	22.7	4.3	13.8	2.5	0.2	0.0	16.5	SIL
BPT5-24	168-175	66-69		20.9	60.3	18.8	38.5	21.8	3.9	12.6	2.2	0.1	0.0	14.9	SIL
BPT5-25	175-183	69-72		21.1	60.4	18.4	39.2	21.2	3.8	12.4	2.1	0.2	0.0	14.7	SIL
BPT5-26	183-191	72-75		20.5	60.2	19.3	39.4	20.8	3.8	13.3	2.1	0.1	0.0	15.5	SIL
BPT5-27	191-198	75-78		21.2	59.4	19.4	38.8	20.6	3.9	13.2	2.1	0.2	0.0	15.6	SIL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
17	3.0	1.5	0.0	.1	4.6	4.1	--	8.7	6.6	--	--	53	70	0.2	5.3	6.0
18	3.1	1.6	0.0	.1	4.8	3.9	--	8.7	7.1	--	--	55	68	0.2	5.3	5.9
19	3.8	2.0	0.0	.2	6.0	3.9	--	9.8	8.3	--	--	61	72	0.2	5.3	5.9
20	3.3	2.0	TR	.2	5.5	4.1	--	9.6	8.0	--	--	57	69	0.2	5.3	5.9
21	3.1	2.0	0.0	.2	5.3	4.6	--	9.8	8.0	--	--	54	66	0.2	5.2	5.9
22	3.4	2.0	0.0	.2	5.6	5.0	--	10.6	8.3	--	--	53	67	0.2	5.2	5.9
23	3.6	2.0	TR	.2	5.8	5.3	--	11.1	8.7	--	--	52	67	0.2	5.2	5.9
24	3.8	2.4	0.0	.2	6.4	5.2	--	11.6	9.2	--	--	55	70	0.2	5.2	5.9
25	4.2	2.3	.1	.2	6.8	5.6	--	12.4	9.3	--	--	55	73	0.2	5.1	5.8
26	4.5	1.9	TR	.2	6.6	5.6	--	12.2	9.1	--	--	54	73	0.2	5.2	5.9
27	4.5	2.0	TR	.2	6.7	4.9	--	11.6	9.3	--	--	58	72	0.2	5.2	5.9

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	CLAY < .002	SILT .002 -.05	SAND .05 -2	FINE .002 -.02	COARSE .02 -.05	VF .05 -.10	F .10 -.25	M .25 -.50	C .5 -1	VC 1 -2	>VF .10 -2	TEXT CLASS
				-----TOTAL------			---SILT----		------------SAND------------						
				---------------------% of < 2mm---------------------------											
BPT5W-1	0-8	0-3		15.8	64.9	19.3	40.5	24.4	5.2	9.9	3.1	0.7	0.4	14.1	SIL
BPT5W-2	8-18	3-7		12.9	64.6	22.5	42.4	22.2	5.5	10.9	3.7	1.4	1.1	17.0	SIL
BPT5W-3	18-23	7-9		15.3	65.9	18.8	44.1	21.9	4.9	8.6	3.0	1.2	1.1	13.9	SIL
BPT5W-4	23-30	9-12		16.3	64.4	19.3	42.0	22.4	5.2	9.1	3.0	1.1	0.8	14.1	SIL
BPT5W-5	30-36	12-14		16.9	61.7	21.4	40.5	21.2	5.2	9.9	3.4	1.6	1.4	16.2	SIL
BPT5W-6	36-43	14-17		17.7	58.2	24.2	37.4	20.8	5.1	11.0	3.7	2.6	1.8	19.0	SIL
BPT5W-7	43-51	17-20		19.7	56.4	23.8	38.6	17.8	5.3	11.8	3.9	1.7	1.2	18.6	SIL
BPT5W-8	51-58	20-23		16.8	57.2	26.0	37.8	19.5	4.7	12.3	4.4	2.5	2.1	21.4	SIL
BPT5W-9	58-69	23-27		15.5	55.7	28.7	35.3	20.4	4.7	13.0	5.3	3.5	2.2	24.0	SIL
BPT5W-10	69-76	27-30		14.3	57.1	28.6	36.1	20.9	4.9	13.9	4.8	2.5	2.5	23.7	SIL
BPT5W-11	76-84	30-33		13.8	55.5	30.7	35.0	20.6	4.9	14.1	5.2	3.0	3.5	25.7	SIL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	------CEC------ SUM CATS	NH4 OAc	BASES +Al	Al SAT	BASE SAT SUM	NH4 OAc	ORG C	---pH---- CaCl2 .01M	H2O
	---------------------------meq/100 g------------------										---------%--------					
BPT5w01	7.2	2.4	TR	.2	9.8	7.2	0.0	17.0	13.0	9.8	0	58	75	2.2	5.7	6.1
BPT5w02	5.8	1.5	TR	.1	7.4	6.9	0.0	14.3	10.5	7.4	0	52	70	1.3	5.5	6.1
BPT5w03	5.7	1.6	TR	.1	7.4	6.6	0.0	14.0	10.9	7.4	0	53	68	1.1	5.3	5.9
BPT5w04	5.3	1.1	TR	.1	6.5	7.1	0.0	13.6	10.9	6.5	0	48	60	1.0	5.1	5.7
BPT5w05	5.7	1.2	.1	.1	7.1	7.0	.1	14.1	11.0	7.2	1	50	65	1.0	5.1	5.7
BPT5w06	6.5	1.2	.1	.1	7.9	7.7	.1	15.6	10.9	8.0	1	51	72	0.7	5.1	5.7
BPT5w07	4.9	1.1	.1	.1	6.2	6.1	.2	12.3	10.0	6.4	3	50	62	0.6	5.0	5.6
BPT5w08	4.0	1.2	.1	TR	5.3	6.0	.4	11.3	9.1	5.7	7	47	58	0.5	4.9	5.6
BPT5w09	3.1	.8	.1	.1	4.1	5.9	.5	10.0	7.7	4.6	11	41	53	0.4	4.8	5.4
BPT5w10	2.4	.8	.1	TR	3.3	5.3	.7	8.6	6.8	4.0	18	38	49	0.3	4.7	5.3
BPT5w11	1.9	.8	.1	TR	2.8	5.3	.8	8.1	6.4	3.6	22	35	44	0.3	4.6	5.3

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
BPT5W-12	84-89	33-35		16.4	55.2	28.4	35.8	19.4	4.4	13.1	6.9	2.7	1.2	23.9	SIL
BPT5W-13	89-97	35-38		15.1	55.8	29.0	34.7	21.1	4.9	13.6	6.3	2.8	1.4	24.2	SIL
BPT5W-14	97-104	38-41		12.6	52.4	35.0	33.2	19.2	5.0	14.0	6.5	4.5	5.0	30.0	SIL
BPT5W-15	104-109	41-43		15.1	55.5	29.4	35.4	20.1	4.9	13.4	6.5	2.9	1.7	24.5	SIL
BPT5W-16	109-119	43-47		16.3	55.9	27.7	35.7	20.3	4.5	13.3	6.9	2.2	0.8	23.2	SIL
BPT5W-17	119-127	47-50		17.2	54.2	28.6	34.7	19.5	4.1	13.4	8.2	2.2	0.7	24.6	SIL
BPT5W-18	127-137	50-54		16.8	51.5	31.8	33.2	18.3	3.5	13.8	10.3	3.0	1.2	28.3	SIL
BPT5W-19	137-145	54-57		16.6	48.4	35.0	32.8	15.6	3.2	13.3	11.6	4.3	2.6	31.8	L
BPT5W-20	145-152	57-60		17.8	47.4	34.9	32.1	15.3	3.2	13.9	11.3	4.3	2.2	31.7	L
BPT5W-21	152-160	60-63		16.8	48.9	34.2	33.0	16.0	3.1	13.8	11.4	4.2	1.7	31.1	L
BPT5W-22	160-168	63-66		18.8	50.2	31.1	34.6	15.6	3.1	12.9	9.1	3.9	2.0	27.9	SIL
BPT5W-23	168-183	66-72		20.3	55.2	24.5	38.7	16.5	3.1	10.7	5.8	3.0	1.8	21.4	SIL
BPT5W-24	183-191	72-75		20.8	60.6	18.6	42.0	18.5	3.0	7.9	3.3	2.3	2.2	15.7	SIL
BPT5W-25	191-198	75-78		23.5	64.8	11.7	47.1	17.8	2.3	4.8	1.8	1.4	1.4	9.4	SIL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
12	1.4	.7	0.0	.1	2.2	6.3	.8	8.5	6.3	3.0	27	26	35	0.2	4.4	-5.2
13	1.4	.8	0.0	TR	2.2	5.8	.9	8.0	6.6	3.1	29	28	33	0.2	4.5	5.2
14	1.0	.8	0.0	TR	1.9	5.6	.8	7.5	6.6	2.7	30	25	29	0.2	4.5	5.3
15	1.9	.8	0.0	.1	2.8	5.9	1.0	8.7	7.8	3.8	26	32	36	0.1	4.4	5.2
16	1.9	1.2	0.0	.1	3.2	5.7	1.1	8.8	8.6	4.3	26	36	37	0.1	4.4	5.2
17	1.9	1.2	TR	.1	3.2	5.9	.9	9.1	7.4	4.1	22	35	43	0.1	4.4	5.2
18	1.6	1.5	.1	.1	3.3	6.4	.8	9.7	8.8	4.1	20	34	37	0.1	4.4	5.3
19	1.6	1.5	TR	.1	3.2	5.9	.7	9.1	7.7	3.9	18	35	42	0.1	4.5	5.3
20	1.9	1.6	TR	.1	3.6	5.6	.6	9.2	7.7	4.2	14	39	47	0.1	4.5	5.3
21	1.9	1.6	.1	.1	3.7	7.4	.5	11.1	10.6	4.2	12	33	35	0.1	4.5	5.3
22	2.4	2.4	.1	.1	5.0	5.1	.5	10.1	8.7	5.5	9	50	57	0.1	4.6	5.3
23	2.6	2.8	.1	.1	5.6	6.4	.5	12.0	10.6	6.1	8	47	53	0.1	4.6	5.3
24	2.8	2.7	.2	.1	5.8	6.8	.5	12.6	9.6	6.3	8	46	60	0.1	4.7	5.4
25	3.3	3.4	.2	.1	7.0	7.3	.5	14.3	12.0	7.5	7	49	58	0.1	4.7	5.4

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
BPT7CO-1	0-8	0-3		11.1	59.6	29.3	38.7	20.9	1.5	10.8	9.2	4.6	3.1	27.7	SIL
PBT7CO-2	8-23	3-9		12.2	62.5	25.3	42.1	20.4	1.3	9.5	8.7	3.9	1.9	24.0	SIL
BPT7CO-3	23-43	9-17		21.6	59.0	19.3	41.1	17.9	1.2	7.4	6.4	2.8	1.5	18.1	SIL
BPT7CO-4	43-71	17-28		27.7	48.8	23.5	34.3	14.4	1.3	9.3	8.0	3.3	1.6	22.3	CL
BPT7CO-5	76-102	30-40		19.5	43.3	37.2	28.7	14.6	2.3	15.1	12.3	4.9	2.6	34.9	L
BPT7CO-6	127-152	50-60		15.2	41.9	42.9	26.3	15.6	2.5	13.8	11.7	5.6	9.4	40.4	L
BPT7CO-7	178-198	70-78		25.2	47.4	27.4	30.9	16.5	1.5	9.6	8.3	3.4	4.6	25.9	L

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
BPT7co01	2.1	1.2	TR	.3	3.6	7.9	.3	11.5	9.7	3.9	8	31	37	2.0	4.7	5.3
BPT7co02	.5	.8	0.0	.2	1.5	6.1	.8	7.6	5.8	2.3	35	20	26	0.6	4.5	5.1
BPT7co03	.9	1.6	0.0	.2	2.7	6.0	1.7	8.7	8.0	4.4	39	31	34	0.2	4.4	5.0
BPT7co04	2.7	3.2	TR	.3	6.2	6.8	1.6	13.0	11.5	7.8	21	48	54	0.2	4.5	5.1
BPT7co05	1.2	2.0	.2	.1	3.5	8.5	3.8	12.0	10.1	7.3	52	29	35	0.1	4.1	4.8
BPT7co06	1.0	2.8	.8	.1	4.7	5.8	1.7	10.5	8.6	6.4	27	45	55	0.1	4.3	4.9
BPT7co07	1.7	3.1	1.3	.1	6.2	4.3	.4	10.5	8.6	6.6	6	59	72	0.1	4.7	5.0

FLW-III 94, Big Piney

Pedon	Number	Depth (in.)	Total Wt.	Gravel Wt.	% Gravel
BPT4	1	0 - 2	436	0	0
	2	2 - 6	503	0	0
	3	6 - 9	522	0	0
	4	9 - 12	569	2	0
	5	12 - 15	620	0	0
	6	15 - 18	691	0	0
	7	18 - 21	546	1	0
	8	21 - 25	599	0	0
	9	25 - 28	660	0	0
	10	28 - 31	648	0	0
	11	31 - 34	746	0	0
	12	34 - 36	783	0	0
	13	36 - 39	840	0	0
	14	39 - 41	572	0	0
	15	41 - 44	589	0	0
	16	44 - 48	678	0	0
	17	48 - 51	680	1	0
	18	51 - 54	795	0	0
	19	54 - 56	496	0	0
	20	56 - 59	436	0	0
	21	59 - 62	449	0	0
	22	62 - 65	509	0	0
	23	65 - 68	401	0	0
	24	68 - 70	452	0	0
	25	70 - 73	440	0	0
	26	73 - 76	370	0	0

Pedon	Number	Depth (in.)	Total Wt.	Gravel Wt.	% Gravel
BPT5	1	0 - 2	318	0	0
	2	2 - 6	470	0	0
	3	6 - 8	388	0	0
	4	8 - 11	475	0	0
	5	11 - 13	520	0	0
	6	13 - 16	532	0	0
	7	16 - 19	442	0	0
	8	19 - 21	431	0	0
	9	21 - 25	548	0	0
	10	25 - 28	484	0	0
	11	28 - 31	514	0	0
	12	31 - 34	524	0	0
	13	34 - 36	545	0	0
	14	36 - 39	530	0	0
	15	39 - 42	492	0	0
	16	42 - 45	468	0	0
	17	45 - 48	471	0	0
	18	48 - 51	460	0	0
	19	51 - 54	489	0	0
	20	54 - 57	525	0	0
	21	57 - 60	489	0	0
	22	60 - 63	418	0	0
	23	63 - 66	445	0	0
	24	66 - 69	417	0	0
	25	69 - 72	368	0	0
	26	72 - 75	435	0	0
	27	75 - 78	389	0	0

FLW-III 94, Big Piney

Pedon	Number	Depth (in.)	Total Wt.	Gravel Wt.	% Gravel
BPT5w	1	0 - 3	350	0	0
	2	3 - 7	429	0	0
	3	7 - 9	404	0	0
	4	9 - 12	430	0	0
	5	12 - 14	412	0	0
	6	14 - 17	406	0	0
	7	17 - 20	465	0	0
	8	20 - 23	430	0	0
	9	23 - 27	501	0	0
	10	27 - 30	517	0	0
	11	30 - 33	514	0	0
	12	33 - 35	500	0	0
	13	35 - 38	568	0	0
	14	38 - 41	451	0	0
	15	41 - 43	547	0	0
	16	43 - 47	450	0	0
	17	47 - 50	473	0	0
	18	50 - 54	511	0	0
	19	54 - 57	531	0	0
	20	57 - 60	483	0	0
	21	60 - 63	454	0	0
	22	63 - 66	460	0	0
	23	66 - 72	446	0	0
	24	72 - 75	474	0	0
	25	75 - 78	443	0	0
BPT7co	1	0 - 3	466	63	14
	2	3 - 9	465	47	10
	3	9 - 17	669	16	2
	4	17 - 28	656	52	8
	5	30 - 40	674	112	17
	6	50 - 60	1015	586	58
	7	70 - 78	584	200	34

FLW
Roubidoux

Ft. Leonard Wood MRT1 pedon 10-26-94 MISSOURI SOIL CHARACTERIZATION LABORATORY

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
1	0-10	0-4	C1	3.0	2.8	94.2	1.8	1.0	0.7	20.2	39.1	20.9	13.2	93.5	COS
2	10-23	4-9	2C2	5.7	9.0	85.3	5.0	4.0	2.0	26.1	31.3	14.1	11.7	83.3	LCOS
3	23-33	9-13	3ACb	5.7	11.0	83.3	7.0	4.1	2.3	34.0	33.7	9.6	3.7	81.0	LS
4	33-46	13-18	3C3	2.6	3.4	94.0	2.1	1.3	0.3	6.0	22.7	34.8	30.1	93.7	COS
5	46-58	18-23	4ACb2	4.3	9.6	86.1	7.0	2.6	1.3	16.2	33.3	20.8	14.5	84.8	LCOS
6	58-71	23-28	4ACb2	2.3	3.7	94.0	2.8	0.9	0.2	7.4	28.3	29.8	28.4	93.8	COS
7	71-86	28-34	5ACb3	8.4	17.2	74.3	11.5	5.7	2.2	31.7	27.6	8.8	4.0	72.2	FSL
8	86-97	34-38	6C4	12.1	26.3	61.5	18.9	7.4	1.3	14.5	20.5	9.9	15.3	60.2	COSL
9	97-109	38-43	7ACb4	7.2	16.4	76.4	11.2	5.2	1.8	20.3	22.2	14.9	17.3	74.6	COSL
10	109-122	43-48	8Ab	18.9	60.0	21.1	41.0	19.0	3.6	9.9	3.6	2.1	1.9	17.5	SIL
11	122-132	48-52	9C5	4.8	7.3	87.9	6.4	1.0	0.5	4.5	19.4	36.4	27.0	87.4	COS
12	132-142	52-56	10Ab2	16.7	49.5	33.8	32.9	16.6	3.3	18.9	9.1	2.3	0.3	30.6	L
13	142-152	56-60	11Cb	6.2	12.2	81.5	8.7	3.5	1.5	35.6	27.6	10.1	6.7	80.0	LS
14	152-178	60-70	12C7	5.3	6.2	88.4	4.2	2.1	0.4	5.3	16.4	21.2	45.2	88.0	COS

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACIDITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
1	1.4	.8	0.0	TR	2.2	1.3	--	3.5	2.4	--	--	63	92	0.2	6.3	7.0
2	3.1	1.2	0.0	.1	4.4	2.0	--	6.4	4.4	--	--	69	100	0.4	6.1	6.8
3	2.9	1.2	0.0	.1	4.2	1.9	--	6.1	5.0	--	--	69	84	0.5	5.8	6.5
4	1.2	.4	0.0	TR	1.6	1.7	--	3.3	2.4	--	--	48	67	0.2	5.8	6.6
5	1.7	.8	0.0	TR	2.5	1.7	--	4.2	3.6	--	--	60	69	0.3	6.0	6.7
6	1.2	.4	0.0	TR	1.6	1.7	--	3.3	2.2	--	--	48	73	0.1	6.0	6.8
7	3.4	1.6	0.0	TR	5.0	2.6	--	7.6	6.4	--	--	66	78	0.6	5.8	6.5
8	4.1	2.0	0.0	.1	6.2	2.9	--	9.1	7.9	--	--	68	78	0.7	5.9	6.6
9	2.6	1.2	0.0	TR	3.8	2.1	--	5.9	4.7	--	--	64	81	0.4	5.7	6.5
10	7.3	3.5	0.0	.1	10.9	5.4	--	16.3	14.1	--	--	67	77	1.4	5.8	6.3
11	2.2	.8	0.0	TR	3.0	2.7	--	5.7	3.5	--	--	53	86	0.4	5.7	6.5
12	5.3	2.8	0.0	.1	8.2	4.5	--	12.7	12.3	--	--	65	67	1.1	5.8	6.4
13	2.9	1.2	0.0	TR	4.1	2.1	--	6.2	4.8	--	--	66	85	0.3	5.8	6.6
14	1.7	.8	0.0	TR	2.5	1.4	--	3.9	3.5	--	--	64	71	0.3	6.1	6.7

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
1	0-20	0-8	A	13.8	36.4	49.8	22.0	14.5	5.8	31.0	11.0	1.7	0.2	44.0	L
2	20-33	8-13	AC1	11.0	26.9	62.1	14.3	12.6	6.2	38.6	15.2	2.0	0.2	55.9	FSL
3	33-46	13-18	AC2	9.2	19.8	71.0	11.4	8.4	4.7	43.8	19.8	2.5	0.2	66.4	FSL
4	46-58	18-23	AC2	12.8	26.6	60.6	15.4	11.2	5.7	37.0	15.2	2.3	0.4	54.9	FSL
5	58-69	23-27	AC3	12.0	26.8	61.3	14.9	11.8	6.7	42.4	10.9	1.2	0.1	54.5	FSL
6	69-81	27-32	AC3	13.6	28.1	58.3	15.8	12.3	6.9	39.9	10.3	1.1	0.1	51.4	FSL
7	81-102	32-40	2Ab1	19.6	49.1	31.2	28.2	21.0	7.2	17.4	5.5	1.1	0.1	24.0	L
8	102-124	40-49	2Ab2	16.7	40.4	42.9	24.0	16.3	4.8	15.3	14.5	6.3	2.0	38.1	L
9	124-150	49-59	2ACb	7.7	19.4	72.8	10.5	8.9	2.8	12.3	28.7	19.7	9.4	70.0	COSL
10	150-168	59-66	3Cb1	1.6	2.2	96.2	0.9	1.3	0.5	13.8	29.1	24.4	28.5	95.8	COS
11	168-180	66-71	3Cb2	2.9	8.5	88.6	4.3	4.1	1.5	19.0	48.9	17.5	1.8	87.1	S
12	180-193	71-76	4Ab3	17.5	45.1	37.4	24.7	20.4	5.4	18.6	10.3	2.6	0.6	32.0	L

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
1	4.8	1.6	TR	.1	6.5	4.2	--	10.7	9.6	--	--	61	68	1.1	5.7	6.3
2	4.5	1.2	.1	.1	5.9	3.1	--	9.0	7.5	--	--	66	79	0.6	5.9	6.6
3	3.4	.8	.2	.1	4.5	2.7	--	7.2	6.7	--	--	63	67	0.5	6.1	6.9
4	4.4	1.2	.5	.1	6.2	3.3	--	9.5	8.8	--	--	65	70	0.7	6.3	7.2
5	3.9	1.2	.8	.1	6.0	2.7	--	8.7	8.0	--	--	69	75	0.5	6.5	7.5
6	4.1	1.2	1.1	.1	6.5	2.9	--	9.3	8.8	--	--	69	74	0.5	6.5	7.5
7	5.5	2.0	1.9	.1	9.5	3.9	--	13.4	12.7	--	--	71	75	0.7	6.5	7.4
8	5.2	2.0	1.6	.1	8.8	3.9	--	12.8	11.0	--	--	70	81	0.6	6.5	7.2
9	2.6	.8	.6	.1	4.1	2.2	--	6.3	5.4	--	--	65	76	0.2	6.1	7.0
10	.7	.4	.1	TR	1.2	1.8	--	3.0	1.7	--	--	40	71	0.1	5.4	6.4
11	1.0	.4	.1	TR	1.5	2.2	--	3.7	2.6	--	--	41	58	0.1	5.3	6.3
12	5.5	2.3	.5	.1	8.3	4.1	--	12.5	11.5	--	--	67	73	0.5	5.7	6.5

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
1	0-20	0-8	Ap	22.4	68.5	9.1	42.8	25.7	4.3	4.3	0.4	0.1	0.2	4.9	SIL
2	20-41	8-16	BA	22.6	67.2	10.2	43.7	23.5	4.3	5.3	0.4	0.1	0.1	5.9	SIL
3	41-61	16-24	Bw1	24.6	67.4	8.0	42.4	25.0	4.1	3.7	0.2	0.0	0.0	3.9	SIL
4	61-81	24-32	Bw1	24.5	63.3	12.3	38.8	24.5	4.6	7.3	0.4	0.0	0.0	7.7	SIL
5	81-97	32-38	Bw2	25.5	65.7	8.9	41.7	23.9	4.4	4.3	0.2	0.0	0.0	4.5	SIL
6	97-114	38-45	Bw2	26.6	67.8	5.6	43.9	23.9	3.2	2.2	0.2	0.0	0.0	2.4	SIL
7	114-137	45-54	Bw3	27.3	69.7	3.0	45.1	24.6	2.1	0.7	0.1	0.1	0.1	0.9	SICL
8	137-163	54-64	Bw4	28.6	68.9	2.5	45.8	23.2	1.8	0.5	0.1	0.1	0.0	0.7	SICL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
1	9.7	3.5	TR	.2	13.4	7.4	--	20.8	18.6	--	--	64	72	2.5	5.2	6.0
2	9.2	2.4	0.0	.1	11.7	6.8	--	18.5	16.6	--	--	63	70	1.2	5.2	5.8
3	8.6	2.4	TR	.1	11.1	5.8	--	16.9	15.0	--	--	66	74	0.8	5.2	5.8
4	8.3	2.4	0.0	.2	11.0	5.4	--	16.4	14.7	--	--	67	75	0.7	5.4	6.1
5	9.0	2.4	0.0	.2	11.6	6.5	--	18.1	15.6	--	--	64	74	0.7	5.4	6.1
6	9.1	2.8	0.0	.2	12.1	6.3	--	18.4	16.7	--	--	66	72	0.7	5.4	6.1
7	7.8	2.4	0.0	.2	10.4	5.9	--	16.3	15.7	--	--	64	66	0.6	5.4	6.1
8	8.2	4.4	TR	.2	12.8	5.9	--	18.7	16.6	--	--	68	77	0.6	5.4	6.0

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
1	0-15	0-6	Ap	17.2	52.0	30.8	31.1	20.9	5.2	14.1	7.6	2.5	1.4	25.6	SIL
2	15-36	6-14	Bw	17.6	46.8	35.6	25.7	21.1	5.3	16.7	9.9	3.0	0.7	30.3	L
3	36-56	14-22	Bt1	14.4	33.6	52.0	18.1	15.5	5.0	25.1	16.5	4.7	0.7	47.0	L
4	56-86	22-34	Bt2	9.8	22.1	68.1	10.6	11.5	4.2	33.6	22.8	6.2	1.3	63.9	FSL
5	86-104	34-41	Bt3	12.1	23.0	64.8	10.6	12.4	5.0	21.7	21.7	11.3	5.2	59.8	MSL
6	104-142	41-56	2C1	1.1	0.9	98.0	0.3	0.6	0.1	3.9	32.2	40.0	22.0	97.9	COS
7	142-163	56-64	2C2	2.8	2.6	94.6	1.0	1.6	0.3	24.8	57.4	11.8	0.4	94.4	S

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
1	5.5	1.6	0.0	.1	7.2	5.9	--	13.1	11.2	--	--	55	64	1.3	5.2	5.8
2	5.4	1.2	0.0	.1	6.7	4.7	--	11.4	10.3	--	--	59	65	0.7	5.2	5.8
3	4.1	.8	0.0	.1	5.0	3.8	--	8.8	7.9	--	--	57	63	0.4	5.3	6.0
4	2.9	.8	0.0	.1	3.8	2.2	--	6.0	5.4	--	--	63	70	0.2	5.3	6.1
5	3.4	TR	0.0	.1	3.6	2.4	--	6.0	6.5	--	--	60	55	0.2	5.6	6.2
6	.2	0.0	0.0	0.0	0.2	.6	--	.8	1.2	--	--	25	17	TR	5.2	6.0
7	.7	0.0	0.0	0.0	0.7	.5	--	1.2	1.5	--	--	58	47	TR	5.2	5.9

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
1	0-15	0-6	Ap	15.5	57.0	27.5	33.6	23.4	6.1	16.0	4.4	0.7	0.4	21.4	SIL
2	15-30	6-12	Bt1	17.2	57.6	25.2	32.5	25.1	5.8	14.0	4.5	0.8	0.2	19.5	SIL
3	30-43	12-17	Bt1	19.6	62.4	18.0	37.5	24.9	5.3	9.2	2.7	0.4	0.2	12.7	SIL
4	43-64	17-25	Bt2	22.3	60.6	17.1	35.8	24.8	5.3	9.3	2.1	0.3	0.1	11.8	SIL
5	64-81	25-32	Bt3	23.9	58.1	18.0	34.2	23.9	5.2	9.6	2.8	0.3	0.0	12.8	SIL
6	81-104	32-41	Bt4	23.0	52.3	24.7	29.4	22.9	5.4	13.5	5.0	0.7	0.1	19.3	SIL
7	104-127	41-50	2Bt5	16.9	36.5	46.6	20.1	16.4	4.8	25.7	13.8	2.1	0.2	41.8	L
8	127-152	50-60	2Bt6	16.0	33.0	51.0	18.0	15.0	5.4	29.8	13.7	2.0	0.1	45.6	L

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
1	4.9	1.5	0.0	.1	6.5	7.0	.1	13.5	11.0	6.6	2	48	59	1.4	5.0	5.5
2	4.6	1.2	0.0	.2	6.0	6.8	.1	12.8	10.4	6.1	2	47	58	0.8	4.9	5.5
3	4.7	1.2	0.0	.2	6.1	6.5	.2	12.6	10.6	6.3	3	48	58	0.7	4.8	5.4
4	5.4	1.2	0.0	.2	6.8	5.8	.1	12.6	10.7	6.9	1	54	64	0.5	4.9	5.6
5	5.6	1.6	0.0	.2	7.4	5.6	.1	13.0	11.2	7.5	1	57	66	0.3	5.2	5.7
6	4.5	2.0	0.0	.1	6.6	5.9	.2	12.5	10.8	6.8	3	53	61	0.3	4.9	5.6
7	2.4	1.6	0.0	.1	4.1	5.4	1.1	9.5	8.6	5.2	21	43	48	0.2	4.6	5.3
8	2.0	1.2	0.0	.1	3.3	5.2	1.0	8.5	7.6	4.3	23	39	43	0.2	4.7	5.4

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
1	0-15	0-6	Ap	21.8	70.5	7.7	42.4	28.1	1.6	2.2	1.5	1.2	1.2	6.1	SIL
2	15-30	6-12	Ap	26.4	67.0	6.6	43.7	23.3	1.3	1.6	1.3	1.1	1.3	5.3	SIL
3	30-48	12-19	Bt1	54.0	41.6	4.4	28.7	12.9	0.7	1.2	0.8	0.8	0.8	3.7	SIC
4	48-69	19-27	Bt1	52.0	38.7	9.3	25.9	12.8	1.1	3.3	2.1	1.4	1.4	8.2	C
5	69-89	27-35	Bt2	47.6	39.9	12.5	24.7	15.2	1.9	5.1	3.0	1.4	0.9	10.5	C
6	89-104	35-41	2Bt3	44.5	42.9	12.6	26.0	16.9	1.9	5.2	3.3	1.5	0.8	10.8	SIC
7	104-119	41-47	2Bt3	41.2	41.3	17.6	23.4	17.9	2.5	7.2	4.5	1.9	1.5	15.0	SIC

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
1	4.9	1.6	0.0	.1	6.6	10.6	.1	17.2	10.9	6.7	1	38	61	2.5	4.9	5.4
2	5.3	1.6	0.0	.1	7.0	8.1	.1	15.1	10.6	7.1	1	46	66	1.6	5.0	5.6
3	11.7	10.2	.3	.3	22.5	13.3	.4	35.8	34.0	22.9	2	63	66	1.1	4.9	5.3
4	10.5	9.1	.4	.3	20.3	14.1	.8	34.4	30.9	21.1	4	59	66	0.9	4.8	5.3
5	9.5	8.2	.4	.3	18.4	10.4	.3	28.8	26.6	18.7	2	64	69	0.7	4.9	5.4
6	9.1	7.9	.4	.3	17.7	8.0	0.0	25.7	24.4	17.7	0	69	73	0.5	5.3	5.8
7	8.6	7.5	.4	.3	16.8	6.2	0.0	23.0	21.7	16.8	0	73	77	0.3	5.5	5.8

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
1	0-13	0-5	Ap	17.2	72.5	10.2	48.2	24.3	1.3	2.5	2.2	2.0	2.2	9.0	SIL
2	13-28	5-11	E	19.4	68.6	12.0	45.7	22.9	1.0	2.3	2.2	2.3	4.0	10.9	SIL
3	28-38	11-15	Bt1	43.9	52.6	3.5	35.7	16.9	0.6	1.0	0.9	0.6	0.3	2.9	SIC
4	38-58	15-23	Bt2	57.2	40.0	2.8	26.1	13.9	0.5	0.9	0.7	0.4	0.3	2.3	SIC
5	58-81	23-32	Bt2	52.4	42.9	4.7	27.3	15.5	0.7	1.6	1.3	0.7	0.4	4.0	SIC
6	81-107	32-42	2Bt3	28.2	54.1	17.7	32.8	21.3	2.2	6.6	5.4	2.3	1.1	15.4	SICL
7	107-132	42-52	2Bt3	31.6	54.7	13.7	33.3	21.5	2.0	4.7	3.6	1.7	1.8	11.7	SICL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
1	4.0	1.6	TR	.1	5.7	10.5	.3	16.2	13.3	6.0	5	35	43	1.9	4.7	5.5
2	2.4	1.2	TR	.1	3.7	9.8	1.3	13.6	11.9	5.0	26	27	31	0.8	4.4	5.1
3	5.0	3.9	.3	.2	9.3	19.1	7.9	28.5	25.4	17.3	46	33	37	0.7	4.2	4.9
4	7.3	6.2	.6	.3	14.4	23.2	10.9	37.6	34.7	25.3	43	38	41	0.9	4.1	4.6
5	7.7	6.4	.8	.3	15.2	18.1	7.5	33.3	30.7	22.7	33	46	50	0.6	4.2	4.7
6	4.7	3.5	.4	.1	8.7	6.5	1.1	15.2	14.2	9.8	11	57	61	0.2	4.7	5.5
7	5.9	4.3	.5	.1	10.8	5.5	0.0	16.3	15.6	10.8	0	66	69	0.2	5.2	5.7

Ft. Leonard Wood MRT7 pedon 10-26-94 MISSOURI SOIL CHARACTERIZATION LABORATORY

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
1	0-13	0-5	Ap	14.4	43.1	42.5	27.8	15.3	1.6	14.0	17.2	7.4	2.2	40.8	L
2	13-33	5-13	Bt1	25.6	39.7	34.7	27.1	12.6	1.5	11.8	13.3	6.5	1.4	33.2	L
3	33-46	13-18	Bt2	24.0	36.6	39.4	24.3	12.3	1.5	12.3	15.7	7.7	2.2	37.9	L
4	46-61	18-24	Bt2	24.5	36.3	39.2	24.2	12.1	1.7	13.0	15.4	7.4	1.7	37.6	L
5	61-71	24-28	Bt3	22.8	36.9	40.2	24.2	12.7	1.5	12.8	15.8	7.8	2.3	38.8	L
6	71-84	28-33	Bt3	19.8	34.1	46.1	22.3	11.8	1.6	13.9	19.0	9.5	2.2	44.5	L
7	84-124	33-49	2Bt4	17.3	32.6	50.1	19.9	12.6	2.0	16.5	19.3	9.0	3.3	48.1	L
8	124-178	49-70	2Bt5	19.9	29.6	50.5	17.3	12.4	2.0	16.9	18.9	7.8	4.8	48.5	L

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
1	3.4	1.2	0.0	.3	4.9	5.7	0.0	10.6	9.0	4.9	0	46	54	1.2	5.0	5.6
2	3.9	2.0	0.0	.6	6.5	5.9	0.0	12.4	10.9	6.5	0	52	60	0.4	5.3	5.6
3	3.6	2.4	0.0	.8	6.8	4.5	0.0	11.3	10.6	6.8	0	60	64	0.2	5.1	5.6
4	3.3	2.0	0.0	.9	6.2	4.8	0.0	11.0	10.0	6.2	0	56	62	0.2	5.3	5.8
5	2.9	2.0	0.0	.9	5.8	4.3	0.0	10.1	8.8	5.8	0	57	65	0.1	5.3	5.9
6	2.7	2.0	0.0	.8	5.5	4.8	0.0	10.3	8.8	5.5	0	53	62	0.1	5.1	5.7
7	1.9	1.2	0.0	.7	3.8	3.8	.1	7.6	6.6	3.9	3	50	58	0.1	4.9	5.7
8	2.1	1.6	0.0	.7	4.4	3.9	.1	8.3	6.9	4.5	2	53	64	0.1	4.9	5.4

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL: CLAY < .002	TOTAL: SILT .002 -.05	TOTAL: SAND .05 -2	SILT: FINE .002 -.02	SILT: COARSE .02 -.05	SAND: VF .05 -.10	SAND: F .10 -.25	SAND: M .25 -.50	SAND: C .5 -1	SAND: VC 1 -2	SAND: >VF .10 -2	TEXT CLASS
				% of < 2mm											
1	0-18	0-7	A1	13.5	30.9	55.6	18.5	12.3	2.6	22.5	20.1	7.9	2.4	53.0	MSL
2	18-33	7-13	A1	10.7	19.8	69.5	11.3	8.5	2.0	22.0	25.7	12.9	7.1	67.6	MSL
3	33-48	13-19	A2	12.9	20.2	66.9	12.1	8.2	2.3	22.4	23.5	10.4	8.3	64.6	MSL
4	48-71	19-28	2Ab1	18.6	25.4	56.0	15.7	9.7	2.2	16.1	15.2	8.2	14.2	53.7	MSL
5	71-89	28-35	2Ab2	24.7	23.9	51.4	15.0	8.9	1.6	13.6	15.7	9.1	11.4	49.8	SCL
6	89-117	35-46	2Ab3	18.9	16.5	64.6	9.7	6.8	1.4	14.4	25.1	13.1	10.5	63.2	MSL
7	117-130	46-51	3Ab4	22.0	20.8	57.2	13.0	7.7	2.0	19.2	20.6	8.3	7.2	55.2	SCL
8	130-150	51-59	3Ab5	23.3	16.7	60.0	10.0	6.7	1.1	10.9	15.4	10.8	21.9	58.9	SCL
9	150-163	59-64	3Ab6	22.6	14.8	62.5	8.8	6.0	0.8	5.8	12.2	15.6	28.1	61.8	SCL

SAMPLE #	NH4OAc EXTRACTABLE BASES: Ca	Mg	Na	K	SUM BASES	ACIDITY	EXTR Al	CEC: SUM CATS	CEC: NH4 OAc	CEC: BASES +Al	Al SAT	BASE SAT: SUM	BASE SAT: NH4 OAc	ORG C	pH: CaCl2 .01M	pH: H2O
	meq/100 g										%					
1	2.1	1.2	0.0	.2	3.5	7.6	.6	11.1	8.6	4.1	15	32	41	1.0	4.5	5.2
2	2.9	1.2	0.0	.1	4.2	5.7	0.0	9.8	7.4	4.2	0	42	57	0.7	4.8	5.5
3	2.4	1.6	0.0	.1	4.1	5.2	0.0	9.3	7.3	4.1	0	44	56	0.5	4.8	5.5
4	3.4	2.0	0.0	.1	5.5	8.3	.6	13.9	11.2	6.1	10	40	49	0.8	4.5	5.3
5	5.6	2.4	0.0	.1	8.1	8.3	.2	16.5	14.1	8.3	2	49	57	0.9	4.7	5.2
6	5.1	2.8	TR	.2	8.1	5.0	0.0	13.1	11.4	8.1	0	62	71	0.5	5.2	5.8
7	5.9	3.6	TR	.2	9.7	4.5	0.0	14.2	12.2	9.7	0	68	80	0.5	5.7	6.3
8	6.1	3.9	TR	.2	10.2	4.2	0.0	14.4	13.0	10.2	0	71	78	0.5	5.9	6.3
9	6.2	3.9	TR	.2	10.3	4.3	0.0	14.6	12.9	10.3	0	71	80	0.5	6.0	6.5

SAMPLE #	DEPTH cm	DEPTH in	HORIZON	TOTAL CLAY < .002	TOTAL SILT .002 -.05	TOTAL SAND .05 -2	SILT FINE .002 -.02	SILT COARSE .02 -.05	SAND VF .05 -.10	SAND F .10 -.25	SAND M .25 -.50	SAND C .5 -1	SAND VC 1 -2	SAND >VF .10 -2	TEXT CLASS
				% of < 2mm											
1	0-30	0-12	Ap	10.3	24.2	65.5	15.5	8.7	2.0	16.1	24.0	11.1	12.4	63.5	MSL
2	30-51	12-20	A	11.6	19.5	68.9	13.1	6.5	1.6	17.6	26.9	15.3	7.6	67.3	MSL
3	51-69	20-27	A	15.4	13.7	70.9	9.3	4.4	0.8	13.0	23.9	15.1	18.0	70.1	COSL
4	69-89	27-35	2Bt1	24.5	9.0	66.5	4.9	4.1	0.6	12.3	25.6	16.1	11.8	65.9	SCL
5	89-109	35-43	2Bt1	22.2	9.1	68.7	5.0	4.1	0.5	9.3	22.4	17.1	19.4	68.2	SCL
6	109-135	43-53	2Bt2	28.2	13.5	58.3	9.1	4.4	0.6	7.1	14.3	13.5	22.8	57.7	SCL
7	135-160	53-63	2Bt2	25.0	8.7	66.3	4.9	3.8	0.3	4.7	17.1	20.2	24.0	66.0	SCL

SAMPLE #	NH4OAc EXTRACTABLE BASES Ca	Mg	Na	K	SUM BASES	ACID-ITY	EXTR Al	CEC SUM CATS	CEC NH4 OAc	CEC BASES +Al	Al SAT	BASE SAT SUM	BASE SAT NH4 OAc	ORG C	pH CaCl2 .01M	pH H2O
	meq/100 g										%					
1	3.1	.8	TR	.1	4.0	8.8	.1	12.9	9.3	4.1	2	31	43	1.5	4.7	5.2
2	2.9	.8	0.0	.1	3.8	3.9	0.0	7.7	6.1	3.8	0	49	62	0.4	5.3	6.1
3	4.1	2.0	0.0	.1	6.2	3.7	0.0	9.8	8.3	6.2	0	63	74	0.4	5.8	6.6
4	5.6	3.2	TR	.2	9.0	2.8	0.0	11.8	11.2	9.0	0	76	80	0.3	5.9	6.5
5	5.6	3.2	0.0	.2	9.0	2.7	0.0	11.7	11.5	9.0	0	77	78	0.3	6.1	6.7
6	7.0	4.4	0.0	.3	11.7	3.7	0.0	15.4	14.3	11.7	0	76	82	0.3	6.3	6.8
7	6.3	4.0	0.0	.2	10.5	2.6	0.0	13.1	12.6	10.5	0	80	83	0.2	6.4	6.9

Pedon	Number	Depth (in.)	Total Wt.	Gravel Wt.	% Gravel
MRT1	1	0 - 4	1093	374	34
	2	4 - 9	1515	917	61
	3	9 - 13	821	163	20
	4	13 - 18	1835	1488	81
	5	18 - 23	1570	1162	74
	6	23 - 28	2568	2132	83
	7	28 - 34	908	150	17
	8	34 - 38	1902	1638	86
	9	38 - 43	810	525	65
	10	43 - 48	533	19	4
	11	48 - 52	876	342	39
	12	52 - 56	767	0	0
	13	56 - 60	1152	158	14
	14	60 - 70	3142	2546	81
MRT2	1	0 - 8	487	1	0
	2	8 - 13	582	0	0
	3	13 - 18	546	0	0
	4	18 - 23	550	0	0
	5	23 - 27	559	0	0
	6	27 - 32	556	0	0
	7	32 - 40	538	0	0
	8	40 - 49	521	2	0
	9	49 - 59	538	16	3
	10	59 - 66	627	214	34
	11	66 - 71	541	1	0
	12	71 - 76	466	0	0
MRT3	1	0 - 8	465	0	0
	2	8 - 16	421	0	0
	3	16 - 24	443	0	0
	4	24 - 32	469	0	0
	5	32 - 38	416	0	0
	6	38 - 45	469	0	0
	7	45 - 54	432	0	0
	8	54 - 64	416	0	0
MRT4	1	0 - 6	507	20	4
	2	6 - 14	531	4	1
	3	14 - 22	546	7	1
	4	22 - 34	518	8	2
	5	34 - 41	595	51	9
	6	41 - 56	1435	846	59
	7	56 - 64	579	0	0

FLW-III 94, Roubidoux

Pedon	Number	Depth (in.)	Total Wt.	Gravel Wt.	% Gravel
MRT5o	1	0 - 6	458	1	0
	2	6 - 12	494	1	0
	3	12 - 17	409	0	0
	4	17 - 25	482	0	0
	5	25 - 32	537	0	0
	6	32 - 41	505	0	0
	7	41 - 50	571	0	0
	8	50 - 60	597	0	0
MRT6o	1	0 - 6	381	1	0
	2	6 - 12	415	1	0
	3	12 - 19	358	0	0
	4	19 - 27	303	1	0
	5	27 - 35	320	0	0
	6	35 - 41	313	1	0
	7	41 - 47	320	0	0
MRT6w	1	0 - 5	322	1	0
	2	5 - 11	351	3	1
	3	11 - 15	289	0	0
	4	15 - 23	397	0	0
	5	23 - 32	447	0	0
	6	32 - 42	428	1	0
	7	42 - 52	464	3	1
MRT7	1	0 - 5	420	24	6
	2	5 - 13	511	3	1
	3	13 - 18	551	24	4
	4	18 - 24	572	19	3
	5	24 - 28	514	58	11
	6	28 - 33	505	54	11
	7	33 - 49	1215	363	30
	8	49 - 70	1132	458	40
	9	70 - 78	missing		
MRTR1	1	0 - 7	540	7	1
	2	7 - 13	575	20	3
	3	13 - 19	597	35	6
	4	19 - 28	617	218	35
	5	28 - 35	619	348	56
	6	35 - 46	624	227	36
	7	46 - 51	600	209	35
	8	51 - 59	588	361	61
	9	59 - 64	499	326	65

Page 2

FLW-III 94, Roubidoux

Pedon	Number	Depth (in.)	Total Wt.	Gravel Wt.	% Gravel
MRTR2	1	0 - 12	1233	777	63
	2	12 - 20	602	80	13
	3	20 - 27	555	243	44
	4	27 - 35	579	304	53
	5	35 - 43	563	239	42
	6	43 - 53	586	298	51
	7	53 - 63	601	262	44

Appendix C
Radiocarbon Test Results

BETA ANALYTIC INC.

RADIOCARBON DATING SERVICES

Dr. JERRY J. STIPP
Dr. MURRY A. TAMERS
CO-CHAIRMEN

DARDEN G. HOOD, P.G.
General Manager

RONALD E. HATFIELD
Laboratory Manager

CHRISTOPHER PATRICK
TERESA A. ZILKO-MILLER
Associate Managers

Dear Colleague:

Enclosed are the radiocarbon dating results on material recently authorized/submitted for analysis. Please recall any correspondences or communications we may have had regarding sample integrity, size, special considerations or conversions from one analytical technique to another. If we have your fax or E-mail number in our records, we have sent the report by electronic mail in addition to the originals being sent by normal first class mail.

Results are obtained on the portion of suitable carbon remaining after necessary chemical and mechanical pretreatments of the submitted material. These pretreatments were applied to isolate ^{14}C which may best represent the time event of interest. Along with each sample result, the individual analysis method, delivery basis, material, and chemical pretreatment is also reported. Pretreatments are defined in the glossary enclosed along with the mailed report copy.

Materials measured by the radiometric technique are analyzed by synthesizing sample carbon to benzene (92% C), measuring for ^{14}C content in one of our 68 liquid scintillation spectrometers, and then calculating for radiocarbon age. AMS results are derived from reduction of sample carbon to graphite (100 %C), along with standards and backgrounds, followed by ^{14}C measurement and calculation in an accelerator-mass-spectrometer located at one of three collaborating laboratories; Lawrence Livermore National Laboratory (CAMS) in California, Eidgenössische Technische Hochschule University (ETH) in Zürich, or Oxford University (Ox) in Oxford, England.

The "Conventional C14 Age (*)" is the result after applying C13/C12 corrections to the measured age and is the most appropriate radiocarbon age (the "*" is discussed at the bottom of the report sheet). Applicable calendar calibration (results 0 to 10,000 BP for organic material, 0 to 8,300 BP for marine carbonates, suitable materials) is reported separately with the original report copy. It is important to read the calibration explanation sheet before interpreting the results.

As always, if you have any specific questions regarding these analyses, please do not hesitate to contact us. We thank you for allowing us to participate in your research and appreciate your prompt attention to payment.

Sincerely,

The directors and professional staff

4985 S.W. 74 COURT, MIAMI, FL, 33155 U.S.A.
TELEPHONE: 305-667-5167 / FAX: 305-663-0964 / E-MAIL: beta@analytic.win.net

PRETREATMENT GLOSSARY

Pretreatment of submitted materials is required to eliminate secondary carbon components. These components, if not eliminated, could result in a radiocarbon date which is too young or too old. Pretreatment does not ensure that the radiocarbon date will represent the time event of interest. This is determined by the sample integrity. The old wood effect, burned intrusive roots, bioturbation, secondary deposition, secondary biogenic activity incorporating recent carbon (bacteria) and the analysis of multiple components of differing age are just some examples of potential problems. The pretreatment philosophy is to reduce the sample to a single component, where possible, to minimize the added subjectivity associated with these types of problems.

"acid/alkali/acid"

The sample was first gently crushed/dispersed in deionized water. It was then given hot HCl acid washes to eliminate carbonates and alkali washes (NaOH) to remove secondary organic acids. The alkali washes were followed by a final acid rinse to neutralize the solution prior to drying. Chemical concentrations, temperatures, exposure times, and number of repetitions, were applied accordingly with the uniqueness of the sample. Each chemical solution was neutralized prior to application of the next. During these serial rinses, mechanical contaminants such as associated sediments and rootlets were eliminated. This type of pretreatment is considered a "full pretreatment".

Typically applied to: charcoal, wood, some peats, some sediments, textiles

"acid washes"

Surface area was increased as much a possible. Solid chunks were crushed, fibrous materials were shredded, and sediments were dispersed. Acid (HCl) was applied repeatedly to ensure the absence of carbonates. Chemical concentrations, temperatures, exposure times, and number of repetitions, were applied accordingly with the uniqueness of each sample. The sample, for a number of reasons, could not be subjected to alkali washes to ensure the absence of secondary organic acids. The most common reason is that the primary carbon is soluble in the alkali. Dating results reflect the total organic content of the analyzed material. Their accuracy depends on the researcher's ability to subjectively eliminate potential contaminants based on contextual facts.

Typically applied to: organic sediments, some peats, small wood or charcoal, special cases

"collagen extraction"

The material was first tested for friability ("softness"). Very soft bone material is an indication of the potential absence of the collagen fraction (basal bone protein acting as a "reinforcing agent" within the crystalline apatite structure). It was then washed in de-ionized water and gently crushed. Dilute, cold HCl acid was repeatedly applied and replenished until the mineral fraction (bone apatite) was eliminated. The collagen was then dissected and inspected for rootlets. Any rootlets present were also removed when replenishing the acid solutions. Where possible, usually dependant on the amount of collagen available, alkali (NaOH) was also applied to ensure the absence of secondary organic acids.

Typically applied to: bones

"acid etch"

The calcareous material was first washed in de-ionized water, removing associated organic sediments and debris (where present). The material was then crushed/dispersed and repeatedly subjected to HCl etches to eliminate secondary carbonate components. In the case of thick shells, the surfaces were physically abraded prior to etching down to a hard, primary core remained. In the case of porous carbonate nodules and caliche, very long exposure times were applied to allow infiltration of the acid. Acid exposure times, concentrations, and number of repetitions, were applied accordingly with the uniqueness of the sample.

Typically applied to: shells, caliche, calcareous nodules

"neutralized"

Carbonates precipitated from ground water are usually submitted in an alkaline condition (ammonium hydroxide or sodium hydroxide solution). Typically this solution is neutralized in the original sample container, using deionized water. If larger volume dilution was required, the precipitate and solution were transferred to a sealed separatory flask and rinsed to neutrality. Exposure to atmosphere was minimal.

Typically applied to: Strontium carbonate, Barium carbonate
(i.e. precipitated ground water samples)

"none"

No laboratory pretreatments were applied. Special requests and pre-laboratory pretreatment usually accounts for this. This would never be the circumstance without the knowledge of the submitter.

BETA ANALYTIC INC.
DR. J.J. STIPP and DR. M.A. TAMERS
UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Paul E. Albertson
US Army Corps of Engineers WES

DATE RECEIVED: October 4, 1993
DATE REPORTED: November 5, 1993
SUBMITTER'S PURCHASE ORDER #

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ±1σ	C13/C12	C13 adjusted ag
Beta-66775 CAMS-9434	FLW HH-17-70 (charcoal)	1990 +/- 60 BP	-23.2 0/00	2020 +/- 60 B
Beta-66776 CAMS-9435	FLW HH-T2-18-64 (charcoal)	370 +/- 60 BP	-26.8 0/00	340 +/- 60 B
Beta-66777 CAMS-9436	FLW HH-T2-25-81 (charcoal)	680 +/- 110 BP	-28.0 0/00	630 +/- 110 B
Beta-66778 CAMS-9437	FLW-T3-15-60 (charcoal)	390 +/- 50 BP	-26.1 0/00	370 +/- 50 B
Beta-66780 CAMS-9438	FLW-RT1-130-52 (charcoal)	3940 +/- 80 BP	-27.4 0/00	3900 +/- 80 B
Beta-66781 CAMS-9439	FLW-RT2-40-32 (charcoal)	4470 +/- 100 BP	-30.1 0/00	4390 +/- 100 B
Beta-66782 CAMS-9440	FLW-RT2-45-66 (charcoal)	4610 +/- 50 BP	-23.8 0/00	4630 +/- 50 B

Note: these samples were done using the AMS technique.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Paul E. Albertson
US Army Corps of Engineers WES

DATE RECEIVED: October 4, 1993
DATE REPORTED: November 2, 1993
SUBMITTER'S PURCHASE ORDER #

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ	C13/C12	C13 adjusted ag
Beta-66779	FLW-RT-1-58-61 (charcoal-0.3gm C)	1370 +/- 100 BP	-24.9 0/00	1370 +/- 100 E

Note: the small sample was given extended counting time.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Mr. Paul E. Albertson
US Army Corps of Engineers

DATE RECEIVED: January 18, 1994
DATE REPORTED: February 11, 1994
SUBMITTER'S PURCHASE ORDER #

TECHNIQUE AND BASIS: Conventional & AMS

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ	C13/C12	C13 adjusted age
Beta-69944 CAMS-11039	FLW-T5-37-42-57 (charred material)*	2420 +/- 80 BP	-24.7 0/00	2420 +/- 80 BP
Beta-69945 CAMS-11040	FLW-T5-45-52-60 (charred material)*	3480 +/- 70 BP	-24.9 0/00	3480 +/- 70 BP
Beta-69947	FLWUR-T5-70-22-25 (charred material- 0.3gm C)**	420 +/- 110 BP	-27.4 0/00	380 +/- 110 BP
Beta-69948	FLWUR-T5-90-38-47 (charred material- 0.4gm C)**	430 +/- 80 BP	-26.8 0/00	400 +/- 80 BP
Beta-69949 CAMS-11041	UR-T4-65-50-56 (charred material)*	2970 +/- 60 BP	-24.6 0/00	2980 +/- 60 BP
Beta-69950 CAMS-11042	UR-T4-90-30-41 (charred material)*	2090 +/- 60 BP	-24.6 0/00	2100 +/- 60 BP
Beta-69951 CAMS-11043	UR-T4-105'-48-50 (charred material)*	2320 +/- 60 BP	-26.0 0/00	2300 +/- 60 BP

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR:Mr. Paul E. Albertson

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ		
Beta-69952 CAMS-11044	UR-T4-126-25 (charred material)*	2390 +/- 60 BP	-25.9 0/00	2380 +/- 60 BP
Beta-69953 CAMS-11045	UR-T4-126-47-49 (charred material)*	2240 +/- 80 BP	-25.9 0/00	2230 +/- 80 BP

* these samples were done using the AMS technique.

** the small samples were given extended counting time.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Mr. Paul E. Albertson
US Army Corps of Engineers

DATE RECEIVED: February 3, 1994
DATE REPORTED: March 2, 1994
SUBMITTER'S PURCHASE ORDER #

TECHNIQUE AND BASIS: Radiometric

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ	C13/C12	C13 adjusted age
Beta-70252	FLW-RT3-40-9 (charred material- 0.3 grams C)*	420 +/- 100 BP	-29.4 0/00	350 +/- 100 BP

* The Extended Counting Service was employed to increase precision on the very small sample.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964
E-mail: beta@analytic.win.net

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Mr. Paul E. Albertson
US Army Corps of Engineers

DATE RECEIVED: November 23, 1994
DATE REPORTED: January 3, 1995

Sample Data	Measured C14 Age	C13/C12 Ratio	Conventional C14 Age (*)
Beta-78143 CAMS-17358 SAMPLE #: FLW-MR-T1-HH 47-51" ANALYSIS: AMS MATERIAL/PRETREATMENT:(charred material): acid/alkali/acid	140 +/- 60 BP	-25.4 o/oo	130 +/- 60 BP
Beta-78144 CAMS-17359 SAMPLE #: FLW-MR-T2-24" ANALYSIS: AMS MATERIAL/PRETREATMENT:(charred material): acid/alkali/acid	100 +/- 60 BP	-27.7 o/oo	60 +/- 60 BP
Beta-78145 CAMS-17360 SAMPLE #: FLW-MR-T2-35" ANALYSIS: AMS MATERIAL/PRETREATMENT:(charred material): acid/alkali/acid	880 +/- 60 BP	-27.7 o/oo	840 +/- 60 BP
Beta-78146 CAMS-17361 SAMPLE #: FLW-MR-T2-40" ANALYSIS: AMS MATERIAL/PRETREATMENT:(charred material): acid/alkali/acid	320 +/- 60 BP	-27.5 o/oo	280 +/- 60 BP
Beta-78147 CAMS-17362 SAMPLE #: FLW-MR-T2 24" (8-25-94) ANALYSIS: AMS MATERIAL/PRETREATMENT:(charred material): acid/alkali/acid	30 +/- 60 BP	-25.2 o/oo	30 +/- 60 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By International convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964
E-mail: beta@analytic.win.net

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Mr. Paul E. Albertson

Sample Data	Measured C14 Age	C13/C12 Ratio	Conventional C14 Age (*)
Beta-78148 CAMS-17363 SAMPLE #: FLW-MR-T3 40-42" ANALYSIS: AMS MATERIAL/PRETREATMENT:(charred material): acid/alkali/acid	1390 +/- 70 BP	-25.3 o/oo	1390 +/- 70 BP
Beta-78149 CAMS-17364 SAMPLE #: FLW-MR-T3-60" ANALYSIS: AMS MATERIAL/PRETREATMENT:(charred material): acid/alkali/acid	1910 +/- 60 BP	-26.7 o/oo	1880 +/- 60 BP

Dates are reported as RCYBP (radiocarbon years before present, "present" = 1950A.D.). By international convention, the modern reference standard was 95% of the C14 content of the National Bureau of Standards' Oxalic Acid & calculated using the Libby C14 half life (5568 years). Quoted errors represent 1 standard deviation statistics (68% probability) & are based on combined measurements of the sample, background, and modern reference standards.

Measured C13/C12 ratios were calculated relative to the PDB-1 international standard and the RCYBP ages were normalized to -25 per mil. If the ratio and age are accompanied by an (*), then the C13/C12 value was estimated, based on values typical of the material type. The quoted results are NOT calibrated to calendar years. Calibration to calendar years should be calculated using the Conventional C14 age.

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Dr. Robert Jacobson
U.S. Geological Survey WRD

DATE RECEIVED: January 12, 1994
DATE REPORTED: February 18, 1994
SUBMITTER'S PURCHASE ORDER #

TECHNIQUE AND BASIS: AMS

not flw

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ	C13/C12	C13 adjusted age
Beta-69754 CAMS-11179	RF-TH4-65 (charred material)	400 +/- 80 BP	-24.1 0/00	410 +/- 80 BP
Beta-69756 CAMS-11180	UR-T3-174'-37" (charred material)	1000 +/- 70 BP	-25.2 0/00	1000 +/- 70 BP
Beta-69757 CAMS-11181	UR-T4-20'-22" (charred material)	430 +/- 50 BP	-24.5 0/00	440 +/- 50 BP

Note: these samples were done using the AMS technique.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Robert B. Jacobson
U.S. Geological Survey

DATE RECEIVED: August 23, 1993
DATE REPORTED: October 14, 1993
SUBMITTER'S PURCHASE ORDER #

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ±1σ	C13/C12	C13 adjusted ag
Beta-65481 CAMS-8998	6-28-93-rfth 4 (charcoal)	470 +/- 60 BP	-27.3 0/00	430 +/- 60 B
Beta-65482 CAMS-8999	4-23-93-wbth 11 (charcoal)	8860 +/- 70 BP	-26.3 0/00	8840 +/- 70 B
Beta-65483 CAMS-9000	6-28-93-rfth 5 (charcoal)	1320 +/- 60 BP	-27.3 0/00	1280 +/- 60 B
Beta-65484 CAMS-9001	FLWHH-t2-12-44 (charcoal)	370 +/- 60 BP	-25.7 0/00	360 +/- 60 B
Beta-65485 CAMS-9002	FLWHH-t2-30-51 (charcoal)	210 +/- 60 BP	-25.3 0/00	210 +/- 60 B

not FLW

Note: these samples were done using the AMS technique.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Dr. Robert Jacobson
U.S. Geological Survey WRD

DATE RECEIVED: May 25, 1994

DATE REPORTED: June 22, 1994

SUBMITTER'S PURCHASE ORDER #

TECHNIQUE AND BASIS: AMS

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. $\pm 1\sigma$	C13/C12	C13 adjusted age
Beta-72878 ETH-12358	UR-T5-9'25"-30" (charred material)	420 ± 50 BP	-26.6 o/oo	395 ± 55 BP

Note: the C13 adjusted age-was used to calibrate the radiocarbon age to calendar years.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Dr. Robert Jacobson
U.S. Geological Survey WRD

DATE RECEIVED: January 12, 1994
DATE REPORTED: February 9, 1994
SUBMITTER'S PURCHASE ORDER #

TECHNIQUE AND BASIS:

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. $\pm 1\sigma$	C13/C12	C13 adjusted age
Beta-69755	UR-T3-150' 18"-22" (charred material) (0.3 gram carbon)	450 +/- 100 BP	-28.4 0/00	400 +/- 100 BP

Note: the small sample was given extended counting time.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.

DR. J.J. STIPP and DR. M.A. TAMERS

UNIVERSITY BRANCH
4985 S.W. 74 COURT
MIAMI, FLORIDA, USA 33155
PH: 305/667-5167 FAX: 305/663-0964

REPORT OF RADIOCARBON DATING ANALYSES

FOR: Dr. Robert Jacobson
U.S. Geological Survey WRD

DATE RECEIVED: April 22, 1994
DATE REPORTED: May 17, 1994
SUBMITTER'S PURCHASE ORDER #

TECHNIQUE AND BASIS: Radiometric & AMS

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ	C13/C12	C13 adjusted age
Beta-72212 CAMS-13084	FLW-UR-2-32 (Charred Material)	1560 ± 80 BP	-29.0 o/oo	1490 ± 80 BP
Beta-72213	FLW-ur-T5-80-59 (Charred Material)*	630 ± 80 BP	-26.5 o/oo	610 ± 80 BP
Beta-72214 CAMS-13085	FLW-ur-tr3-105-24 (Charred Material)	1650 ± 60 BP	-27.2 o/oo	1610 ± 60 BP

Note: the C13 adjusted ages were used to calibrate the radiocarbon ages to calendar years.

* The sample contained less than 1 gram of carbon and was given extended counting to increase precision.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard; the adjusted ages are normalized to -25 per mil carbon 13.

BETA ANALYTIC INC.
RADIOCARBON DATING LABORATORY
CALIBRATED C-14 DATING RESULTS

Calibrations of radiocarbon age determinations are applied to convert BP results to calendar years. The short term difference between the two is caused by fluctuations in the heliomagnetic modulation of the galactic cosmic radiation and, recently, large scale burning of fossil fuels and nuclear devices testing. Geomagnetic variations are the probable cause of longer term differences.

The parameters used for the corrections have been obtained through precise analyses of hundreds of samples taken from known-age tree rings of oak, sequoia, and fir up to 7,200 BP. The parameters for older samples, up to 22,000 BP, as well as for all marine samples, have been inferred from other evidence, but have not been conclusively verified.

The Pretoria Calibration Procedure program has been chosen for these dendrocalibrations. It uses splines through the tree-ring data as calibration curves, which eliminates a large part of the statistical scatter of the actual data points. The spline calibration allows adjustment of the average curve by a quantified closeness-of-fit parameter to the measured data points. On the following calibration curves, the solid bars represent one sigma statistics (68% probability) and the hollow bars represent two sigma statistics (95% probability). Marine carbonate samples that have been corrected for $\delta\ ^{13/12}C$, have also been corrected for both global and local geographic reservoir effects (as published in Radiocarbon, Volume 28, Number 2b, 1986) prior to the calibration. Marine carbonates that have not been corrected for $\delta\ ^{13/12}C$, have been adjusted by an assumed value of 0‰ in addition to the reservoir corrections. There are separate calibration data for the Northern and Southern Hemisphere.

(Caveat: the calibrations assume that the material dated was living for exactly twenty years like, for example, a collection of individual tree rings taken from the outer portion of a tree that was cut down to produce the sample in the feature dated. For other materials the maximum and minimum calibrated age ranges given by the computer program could be in error. The possibility of an "old wood effect" must also be considered, as well as the potential inclusion of some younger material in the total sample. Since the vast majority of samples dated probably will not fulfill the twenty-year-criterium and, in addition, an old wood effect or young carbon inclusion might not be excludable, these dendrocalibration results should be used only for illustrative purposes. In the case of marine carbonates, the global reservoir correction is theoretical and the local variations are real, but highly variable and dependant on provenience. The age ranges and, especially, the intercept ages generated by the program must be considered as approximations.)

EXPLANATION OF THE BETA ANALYTIC DENDRO-CALIBRATION PRINTOUT

CALIBRATION OF RADICARBON AGE TO CALENDAR YEARS

Laboratory Number: Beta-12345

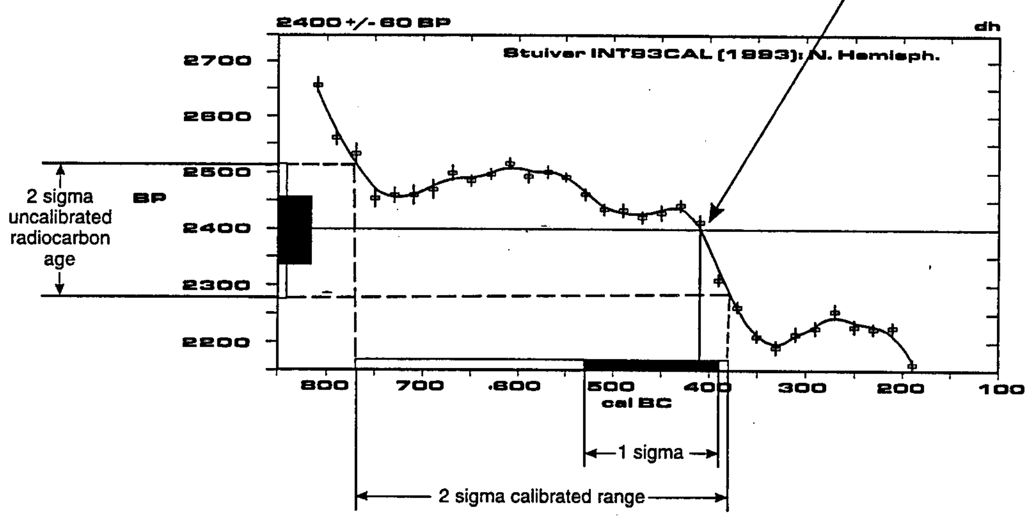
Radiocarbon age: **2400 +/- 60 BP** ← The uncalibrated radiocarbon age (± 1 sigma)

The recommended calibration age range to be used for interpretation → **Calibrated result: (2 sigma, 95% probability)** **cal BC 770 to 380**

Intercept data:

Intercept of radiocarbon age with calibration curve: cal BC 410 ← The intercept between the radiocarbon age & the calibrated calendar time scale curve

The calibration result of the radiocarbon age ± 1 sigma → 1 sigma calibrated result: (68% probability) cal BC 530 to 390



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

Beta Analytic, Inc., 4985 S.W. 74th Court, Miami, Florida 33155

Reporting results (recommended):

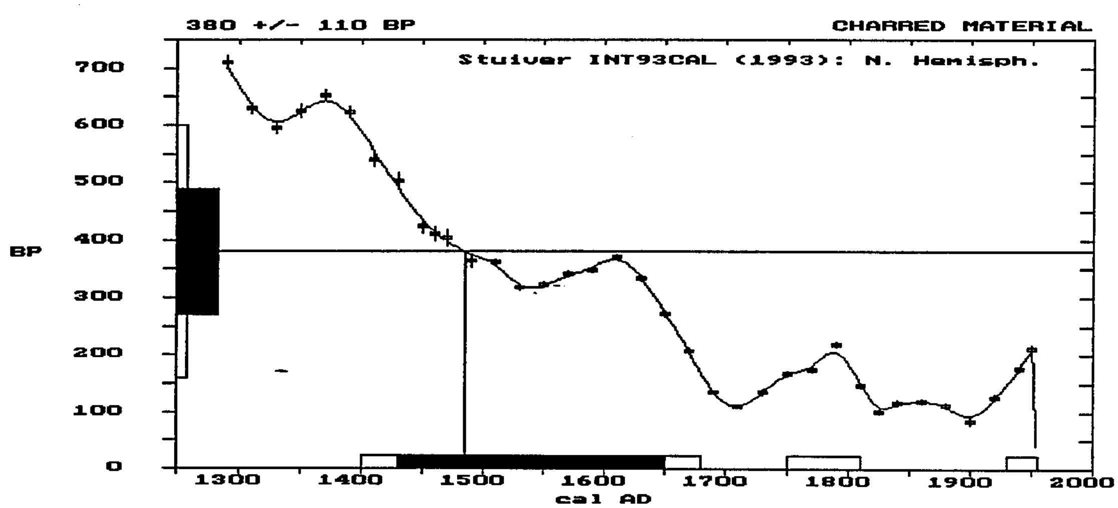
1. List the radiocarbon age with its associated 1 sigma standard deviation in a table and designate it as such.
2. Discussion of ages in the text should focus on the 2 sigma calibrated range.

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-69947
Radiocarbon age:	**380 +/- 110 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal AD 1400 to 1680 and** **cal AD 1750 to 1810** **Cal AD 1930 to 1950**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal AD 1490
1 sigma calibrated result: (68% probability)	cal AD 1430 to 1650



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

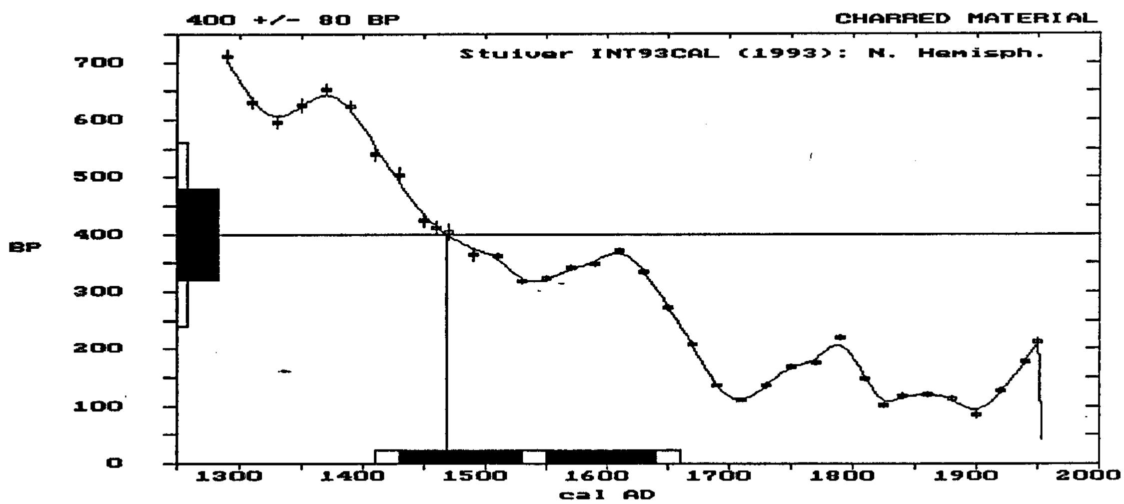
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-69948
Radiocarbon age:	**400 +/- 80 BP**
Calibrated result: (2 sigma, 95% probability)	**cal AD 1410 to 1660**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal AD 1470
1 sigma calibrated results: (68% probability)	cal AD 1430 to 1530 and cal AD 1550 to 1640



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

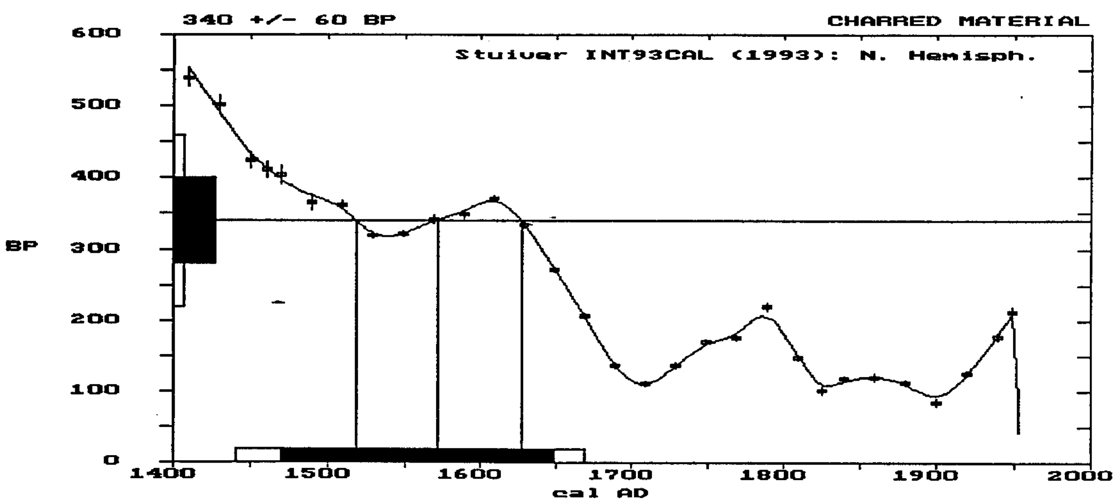
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-66776
Radiocarbon age:	**340 +/- 60 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal AD 1440 to 1670**

Intercept data:

Intercepts of radiocarbon age with calibration curve:	cal AD 1520 and cal AD 1570 and cal AD 1630
1 sigma calibrated result: (68% probability)	cal AD 1470 to 1650



<u>References:</u>

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

<u>Results prepared by:</u>

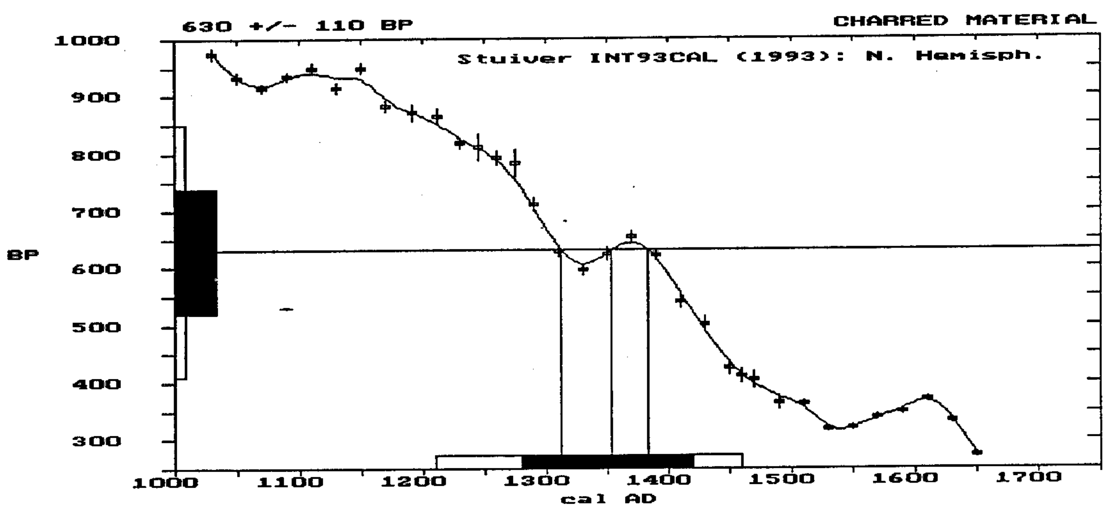
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-66777
Radiocarbon age:	**630 +/- 110 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal AD 1210 to 1460**

Intercept data:

Intercepts of radiocarbon age with calibration curve:	cal AD 1310 and cal AD 1350 and cal AD 1380
1 sigma calibrated result: (68% probability)	cal AD 1280 to 1420



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

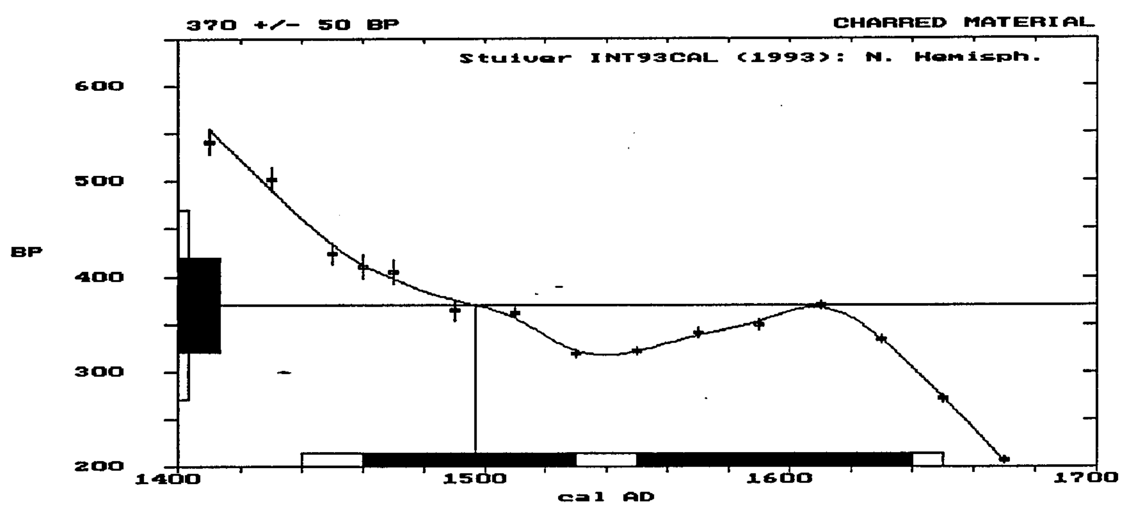
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-66778
Radiocarbon age:	**370 +/- 50 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal AD 1440 to 1650**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal AD 1500
1 sigma calibrated results: (68% probability)	cal AD 1460 to 1530 and cal AD 1550 to 1640



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables:C13/C12=-29.4:lab mult.=1)

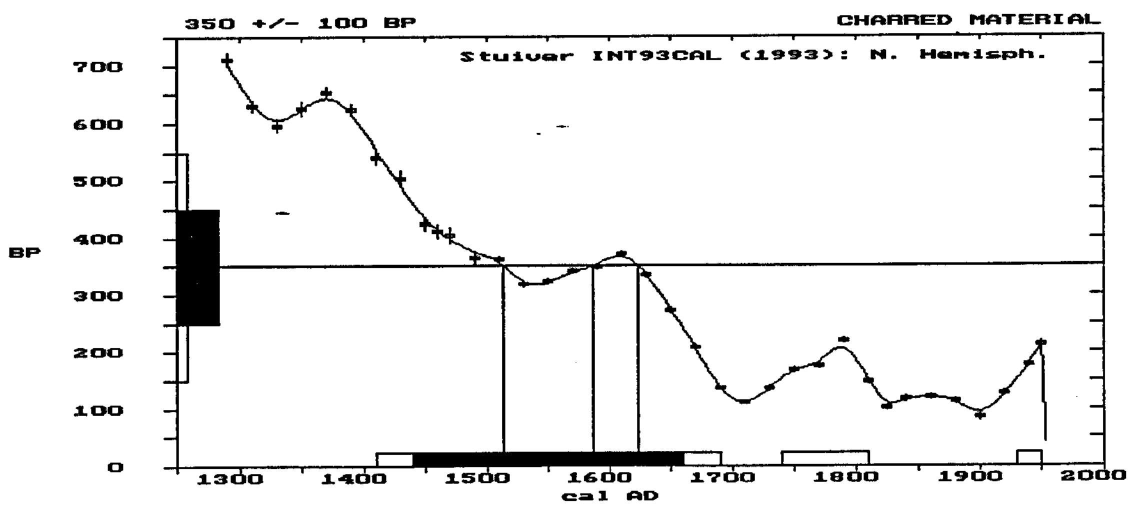
Laboratory Number: Beta-70252

Conventional radiocarbon age*: 350 +/- 100 BP

Calibrated result: (2 sigma, 95% probability)	**cal AD 1410 to 1690 and** **cal AD 1740 to 1810 and** **cal AD 1930 to 1950**

Intercept data:

Intercepts of radiocarbon age with calibration curve:	cal AD 1510 and cal AD 1590 and cal AD 1620
1 sigma calibrated result: (68% probability)	cal AD 1440 to 1660



<u>References:</u>

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

<u>Results prepared by:</u>

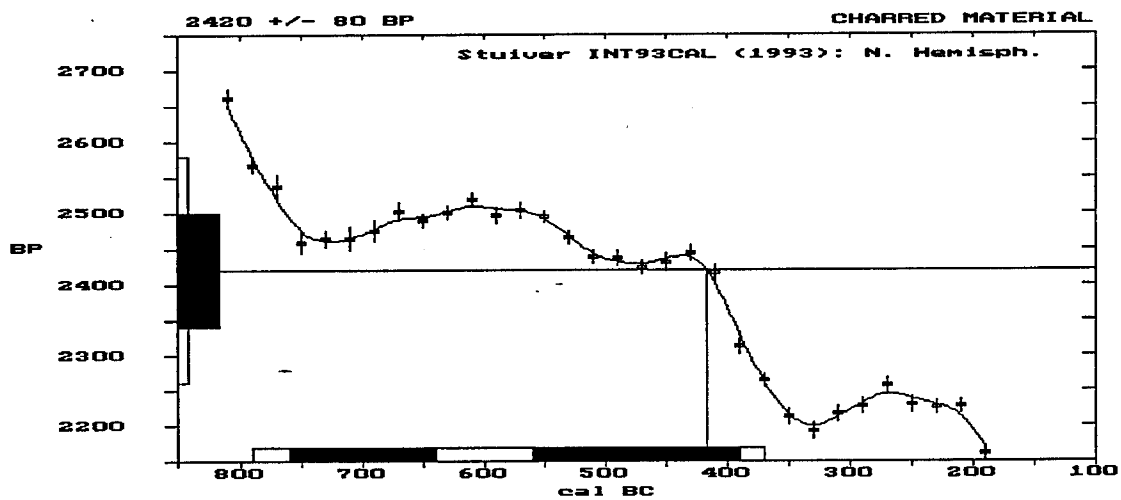
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-69944
Radiocarbon age:	**2420 +/- 80 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal BC 790 to 370**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal BC 420
1 sigma calibrated results: (68% probability)	cal BC 760 to 640 and cal BC 560 to 390



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

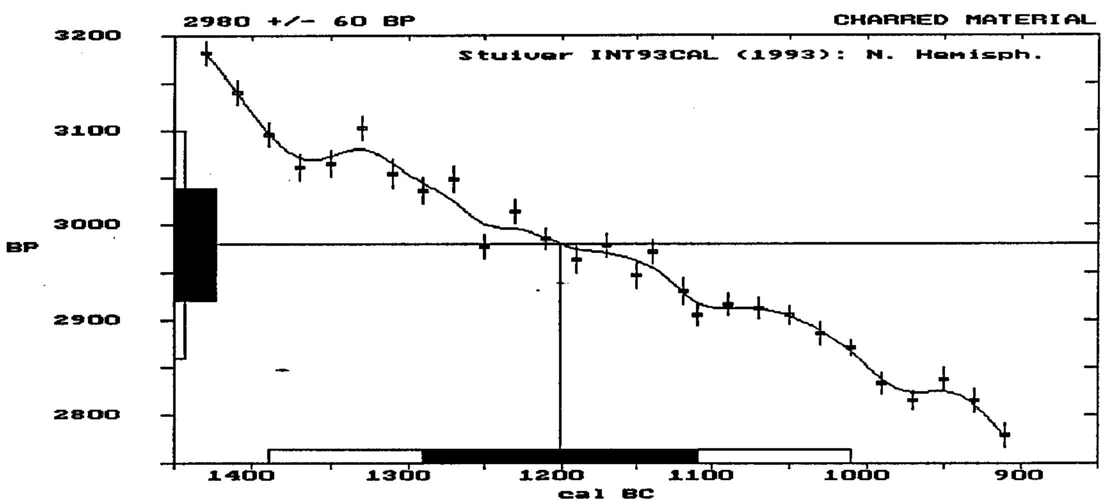
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-69949
Radiocarbon age:	**2980 +/- 60 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal BC 1390 to 1010**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal BC 1200
1 sigma calibrated result: (68% probability)	cal BC 1290 to 1110



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

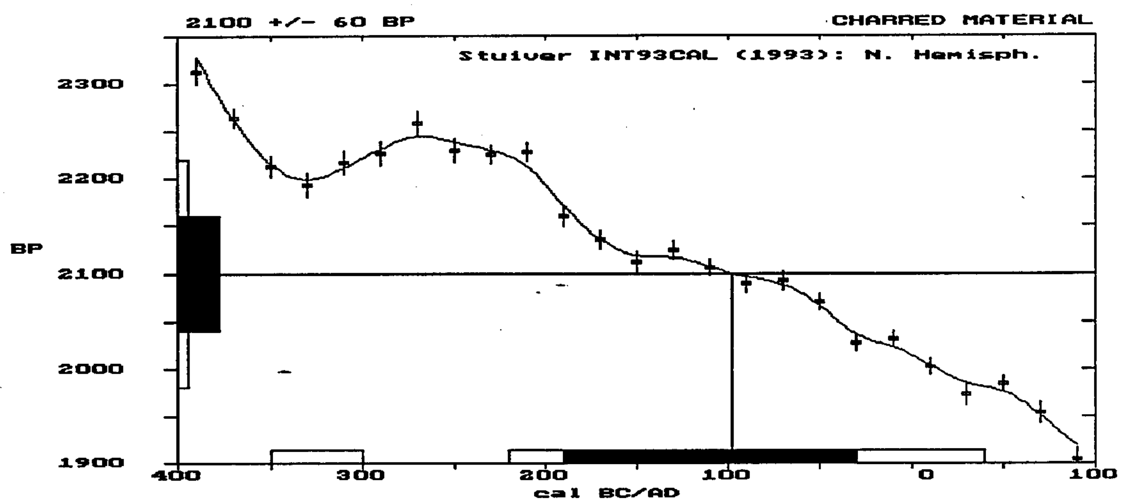
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-69950
Radiocarbon age:	**2100 +/- 60 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal BC 350 to 300 and** **cal BC 220 to cal AD 40**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal BC 100
1 sigma calibrated result: (68% probability)	cal BC 190 to 30



<u>References:</u>

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

<u>Results prepared by:</u>

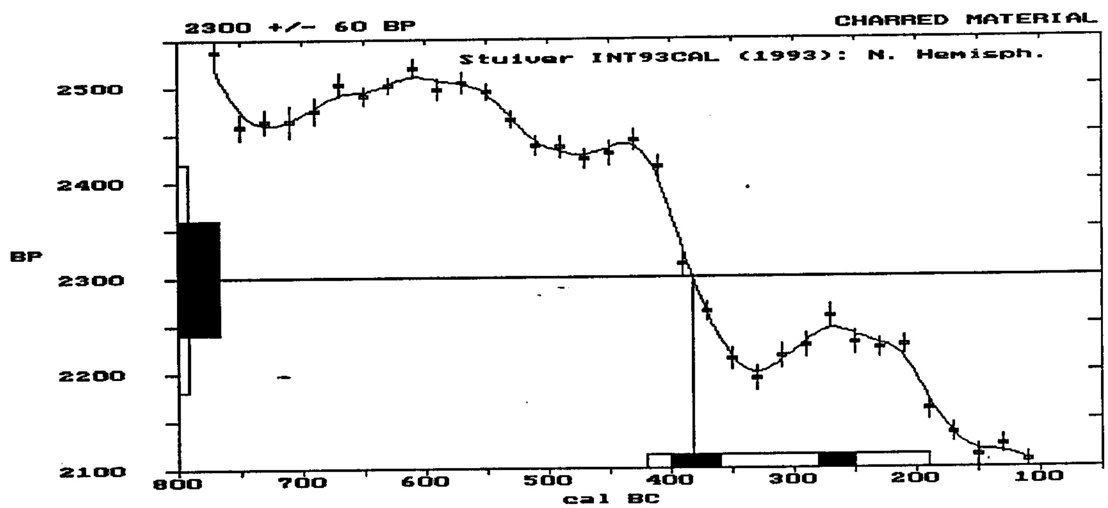
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-69951
Radiocarbon age:	**2300 +/- 60 BP**
Calibrated result: (2 sigma, 95% probability)	**cal BC 420 to 190**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal BC 380
1 sigma calibrated results: (68% probability)	cal BC 400 to 360 and cal BC 280 to 250



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

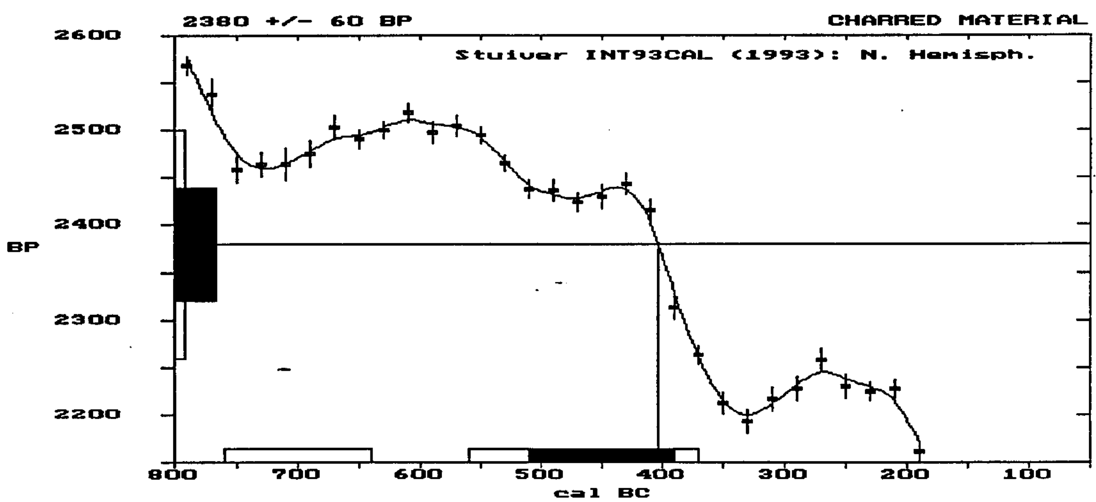
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-69952
Radiocarbon age:	**2380 +/- 60 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal BC 760 to 640 and** **cal BC 560 to 370**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal BC 400
1 sigma calibrated result: (68% probability)	cal BC 510 to 390



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

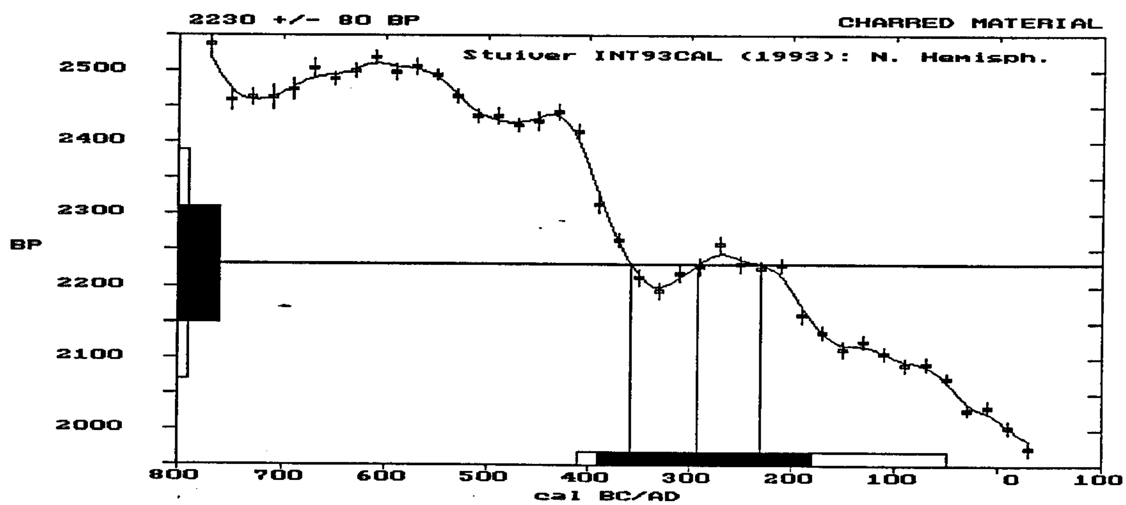
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-69953
Radiocarbon age:	**2230 +/- 80 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal BC 410 to 50**

Intercept data:

Intercepts of radiocarbon age with calibration curve:	cal BC 360 and cal BC 290 and cal BC 230
1 sigma calibrated result: (68% probability)	cal BC 390 to 180



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number: Beta-66775

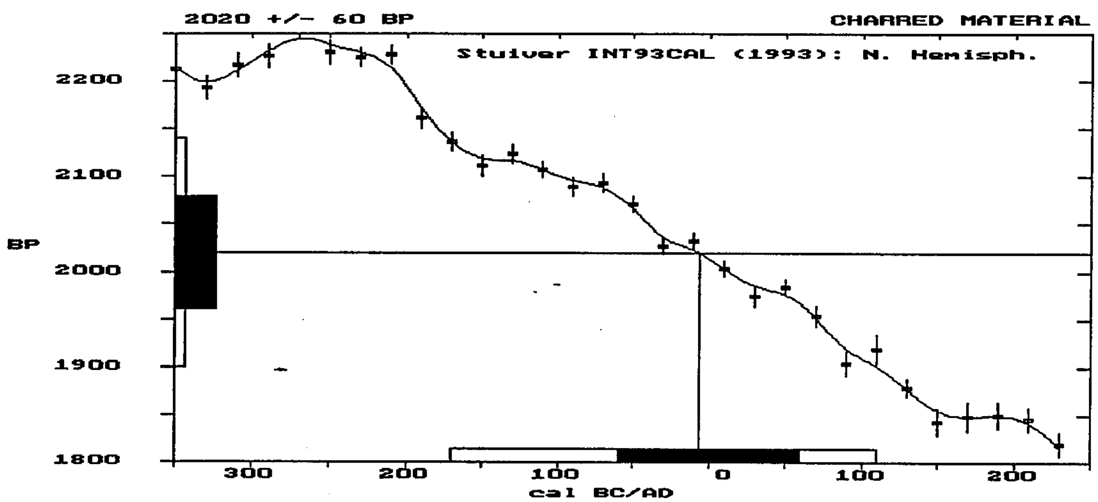
Radiocarbon age: **2020 +/- 60 BP**

Calibrated result: **cal BC 170 to cal AD 110**
(2 sigma, 95% probability)

Intercept data:

Intercept of radiocarbon age
with calibration curve: cal BC 10

1 sigma calibrated result: cal BC 60 to cal AD 60
(68% probability)



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

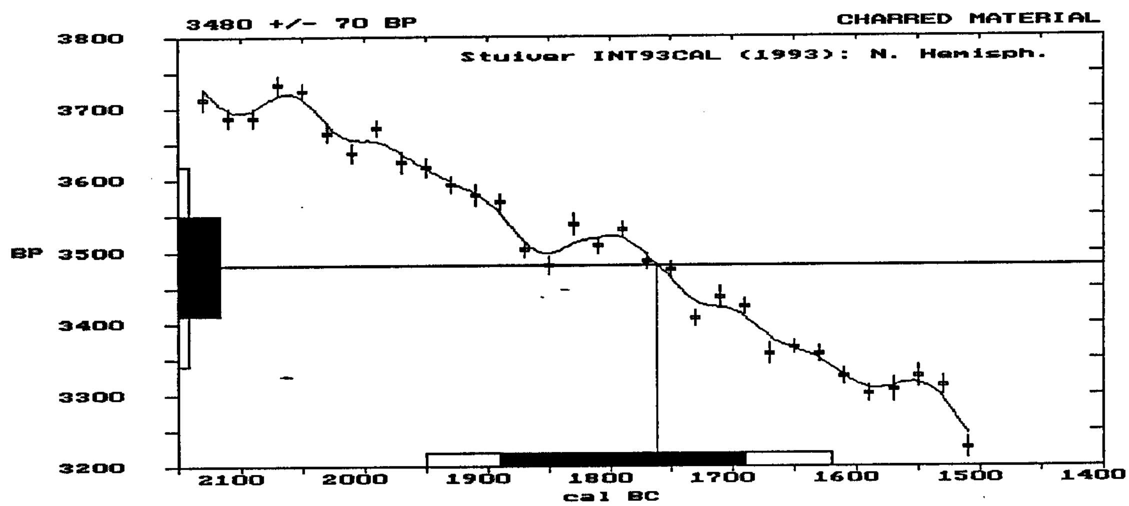
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-69945
Radiocarbon age:	**3480 +/- 70 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal BC 1950 to 1620**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal BC 1760
1 sigma calibrated result: (68% probability)	cal BC 1890 to 1690



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

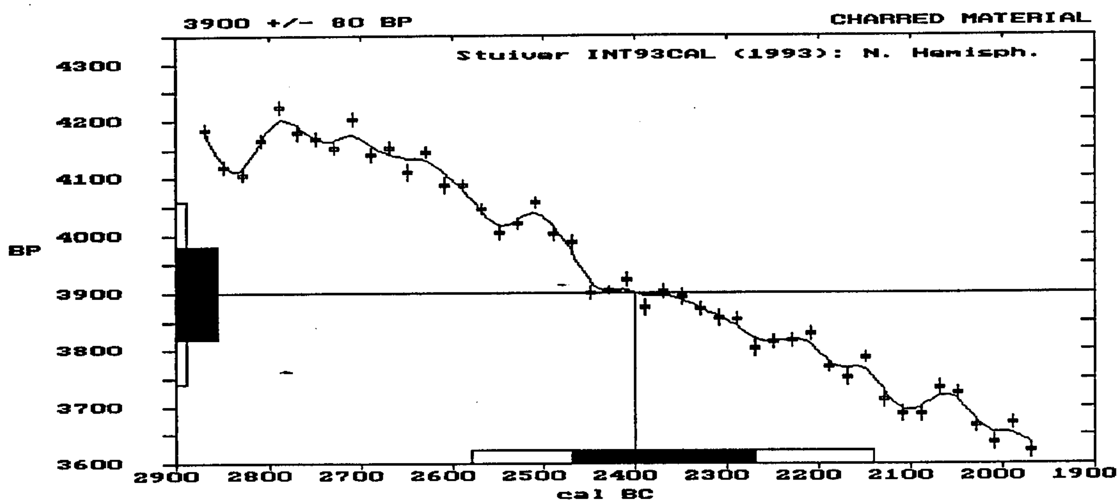
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-66780
Radiocarbon age:	**3900 +/- 80 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal BC 2580 to 2140**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal BC 2400
1 sigma calibrated result: (68% probability)	cal BC 2470 to 2270



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

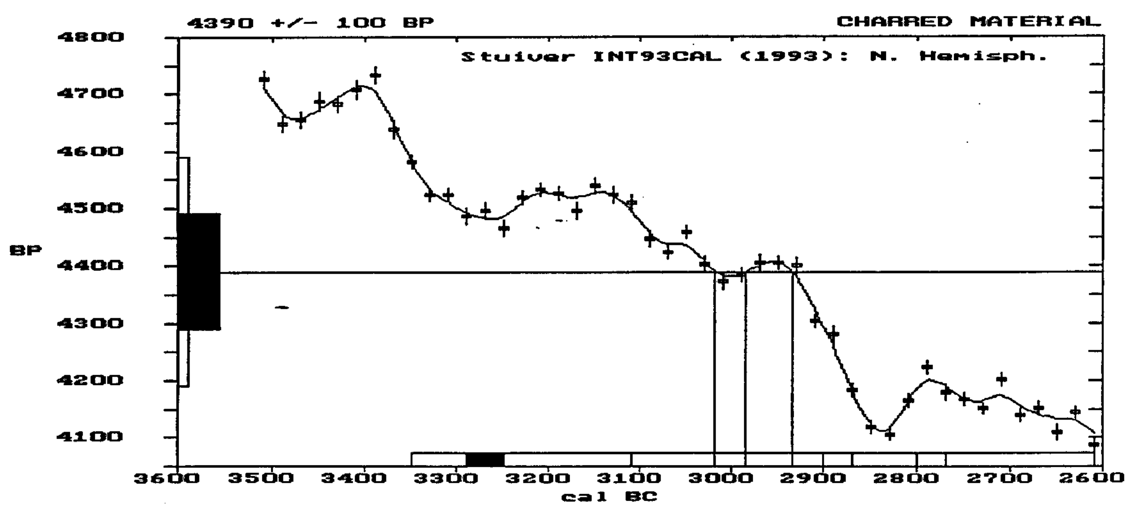
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-66781
Radiocarbon age:	**4390 +/- 100 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal BC 3350 to 2870 and** **cal BC 2800 to 2770**

Intercept data:

Intercepts of radiocarbon age with calibration curve:	cal BC 3020 and cal BC 2990 and cal BC 2930
1 sigma calibrated results: (68% probability)	cal BC 3290 to 3250 and cal BC 3110 to 3110



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

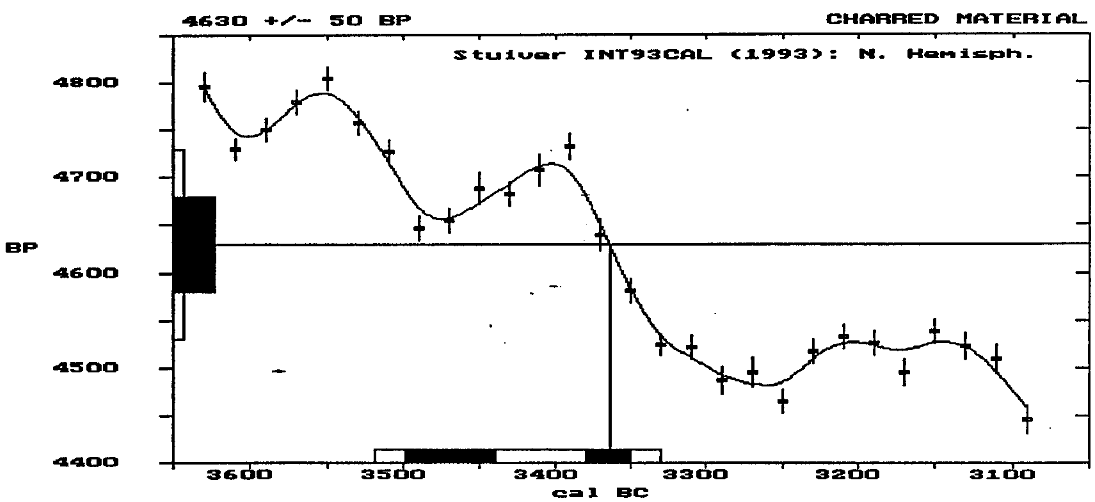
Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

Laboratory Number:	Beta-66782
Radiocarbon age:	**4630 +/- 50 BP**
Calibrated result: **(2 sigma, 95% probability)**	**cal BC 3520 to 3330**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal BC 3360
1 sigma calibrated results: (68% probability)	cal BC 3500 to 3440 and cal BC 3380 to 3350



References:

Vogel, J. C., Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 33(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., 1993, Radiocarbon 35(1)

Results prepared by:

Beta Analytic, Inc., 4985 SW 74th Court, Miami, Florida, 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.4:lab. mult=1)

Laboratory Number: Beta-78143

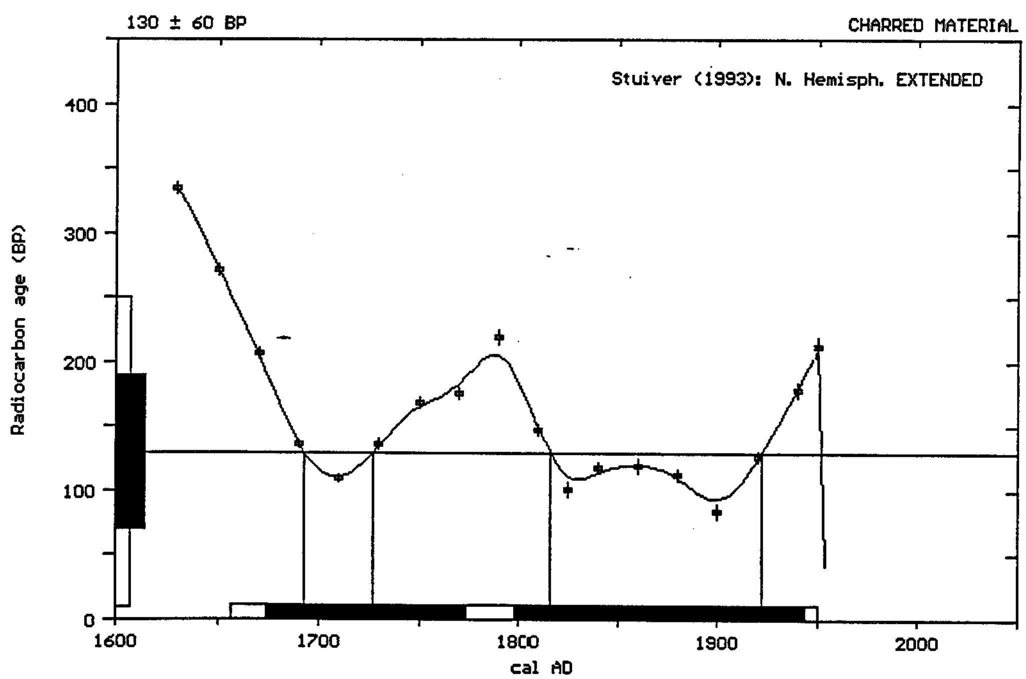
Conventional radiocarbon age: 130 +/- 60 BP

Calibrated results: cal AD 1655 to 1950
(2 sigma, 95% probability)

Intercept data:

Intercepts of radiocarbon age with calibration curve: cal AD 1695 and cal AD 1725 and cal AD 1815 and cal AD 1920

1 sigma calibrated results: cal AD 1675 to 1775 and cal AD 1800 to 1945
(68% probability)



References:

Vogel, J. C.,Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., Radiocarbon 35(1)

Results prepared by:
Beta Analytic, Inc. 4985 S.W. 74th Court, Miami, Florida 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-27.7:lab. mult=1)

Laboratory Number: Beta-78144

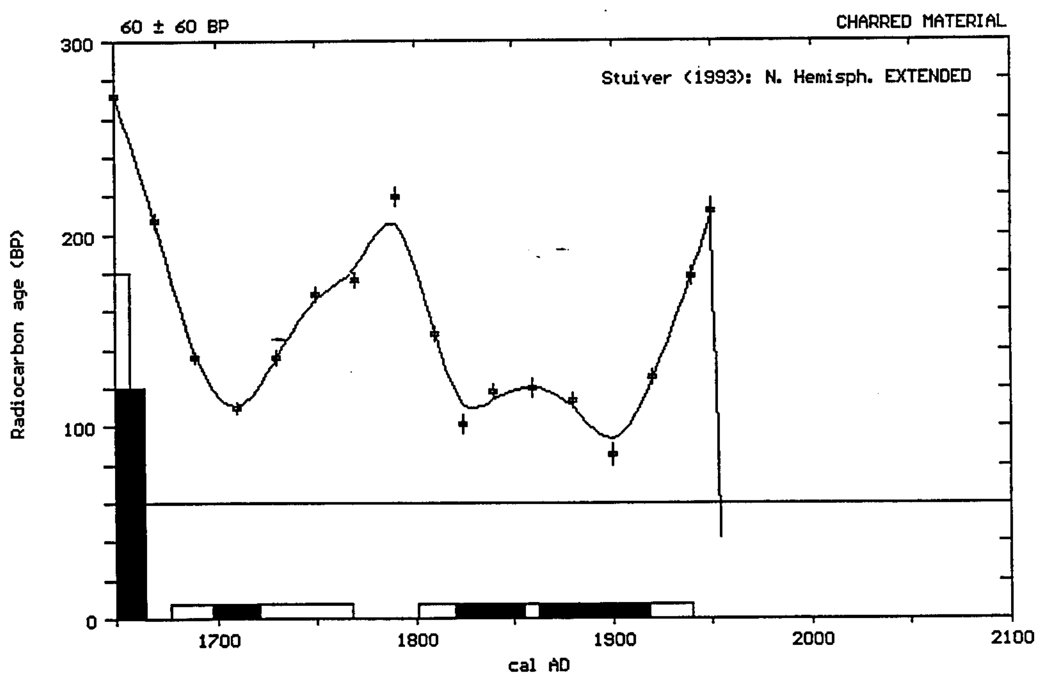
Conventional radiocarbon age: **60 +/- 60 BP**

Calibrated results: **cal AD 1675 to 1770 and**
(2 sigma, 95% probability) **cal AD 1800 to 1940**

Intercept data:

Intercepts of radiocarbon age with calibration curve: NO INTERCEPTS

1 sigma calibrated results: cal AD 1700 to 1720 and
(68% probability) cal AD 1820 to 1855 and
cal AD 1860 to 1920



References:

Vogel, J. C.,Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., Radiocarbon 35(1)

Results prepared by:

Beta Analytic, Inc. 4985 S.W. 74th Court, Miami, Florida 33155

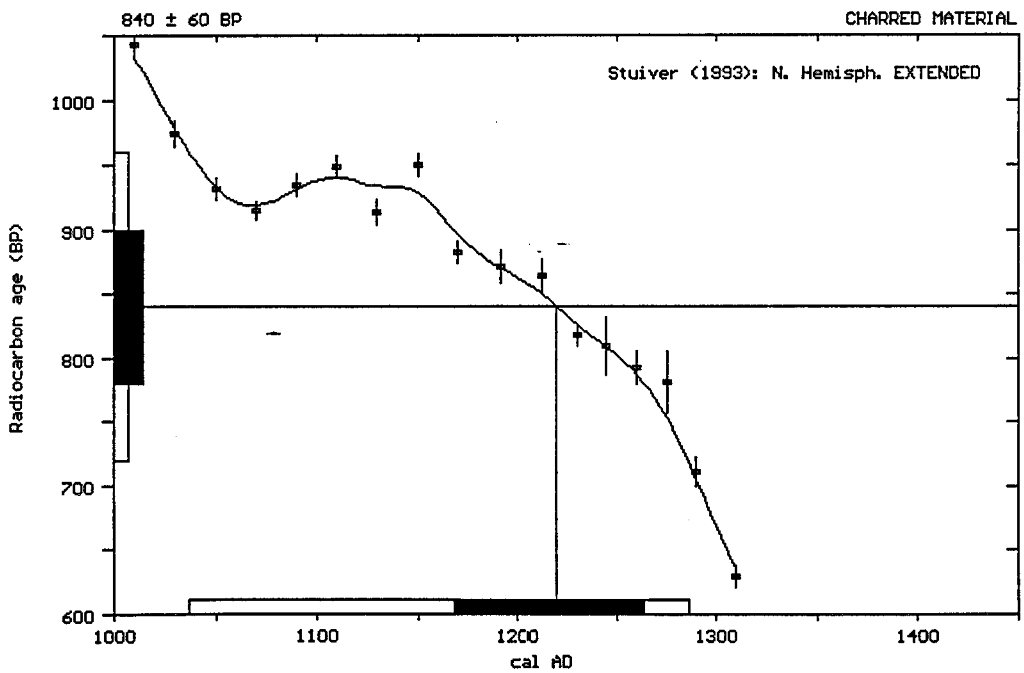
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-27.7:lab. mult=1)

Laboratory Number:	Beta-78145
Conventional radiocarbon age:	**840 +/- 60 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal AD 1035 to 1285**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal AD 1220
1 sigma calibrated results: (68% probability)	cal AD 1170 to 1265



References:

Vogel, J. C.,Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86

Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322

Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., Radiocarbon 35(1)

Results prepared by:

Beta Analytic, Inc. 4985 S.W. 74th Court, Miami, Florida 33155

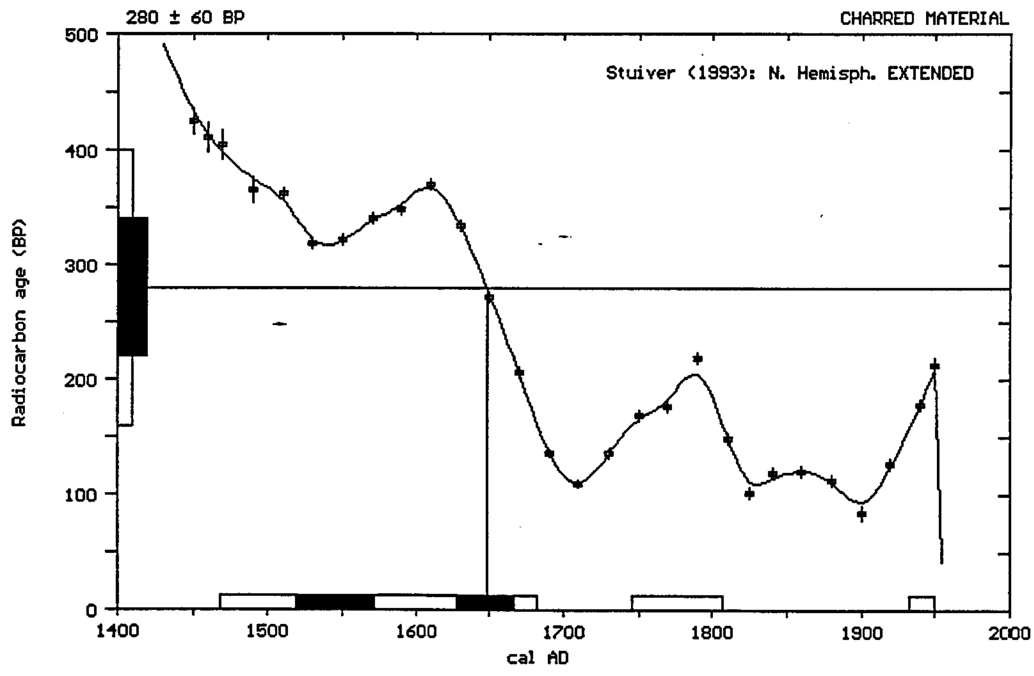
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-27.5:lab. mult=1)

Laboratory Number:	Beta-78146
Conventional radiocarbon age:	**280 +/- 60 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal AD 1470 to 1680 and** **cal AD 1745 to 1805 and** **cal AD 1935 to 1950**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal AD 1650
1 sigma calibrated results: (68% probability)	cal AD 1520 to 1570 and cal AD 1630 to 1665



References:

Vogel, J. C.,Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., Radiocarbon 35(1)

Results prepared by:

Beta Analytic, Inc. 4985 S.W. 74th Court, Miami, Florida 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.2:lab. mult=1)

Laboratory Number: Beta-78147

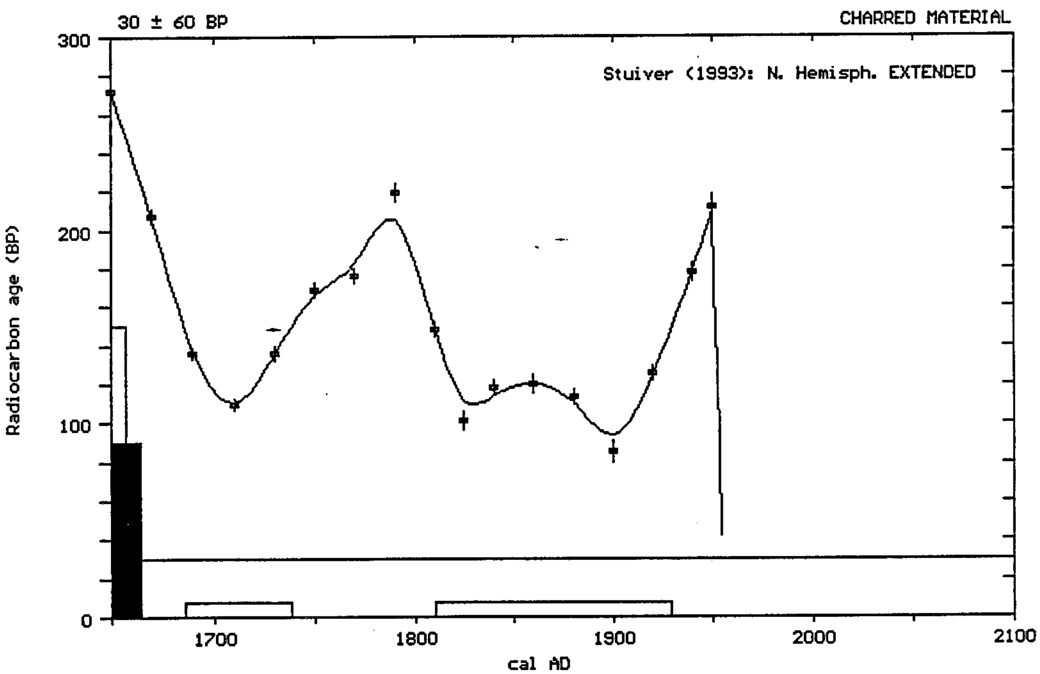
Conventional radiocarbon age: **30 +/- 60 BP**

Calibrated results: **cal AD 1685 to 1740 and**
(2 sigma, 95% probability) **cal AD 1810 to 1930**

Intercept data:

Intercepts of radiocarbon age with calibration curve: NO INTERCEPTS

1 sigma calibrated result: NO INTERCEPTS



References:

Vogel, J. C.,Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., Radiocarbon 35(1)

Results prepared by:
Beta Analytic, Inc. 4985 S.W. 74th Court, Miami, Florida 33155

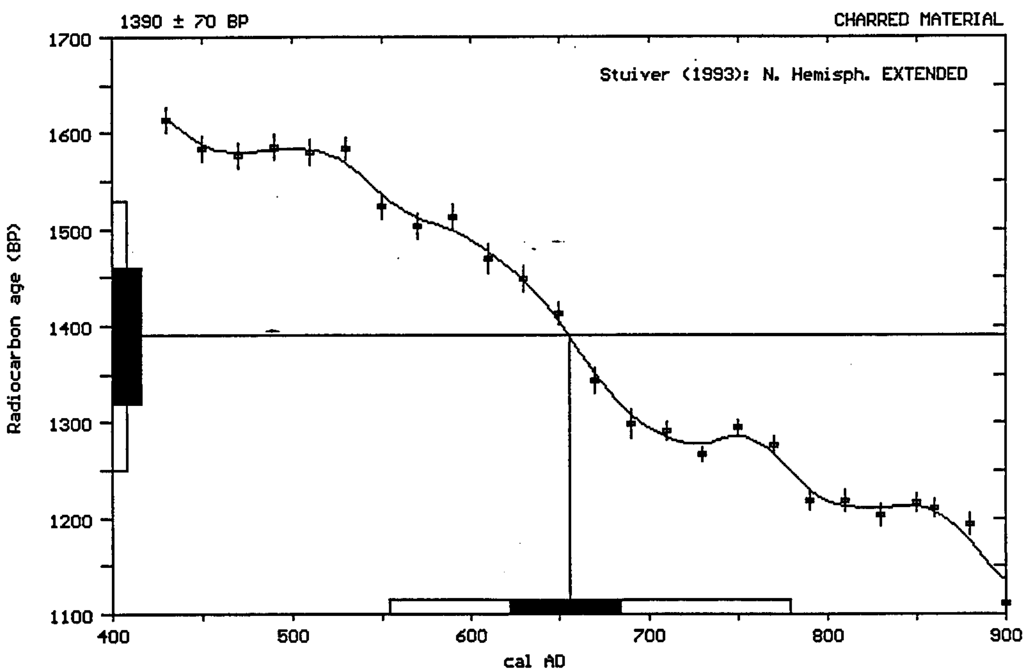
CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-25.3:lab. mult=1)

Laboratory Number:	Beta-78148
Conventional radiocarbon age:	**1390 +/- 70 BP**
Calibrated results: **(2 sigma, 95% probability)**	**cal AD 555 to 780**

Intercept data:

Intercept of radiocarbon age with calibration curve:	cal AD 655
1 sigma calibrated results: (68% probability)	cal AD 620 to 685



References:

Vogel, J. C.,Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., Radiocarbon 35(1)

Results prepared by:
Beta Analytic, Inc. 4985 S.W. 74th Court, Miami, Florida 33155

CALIBRATION OF RADIOCARBON AGE TO CALENDAR YEARS

(Variables: C13/C12=-26.7:lab. mult=1)

Laboratory Number: Beta-78149

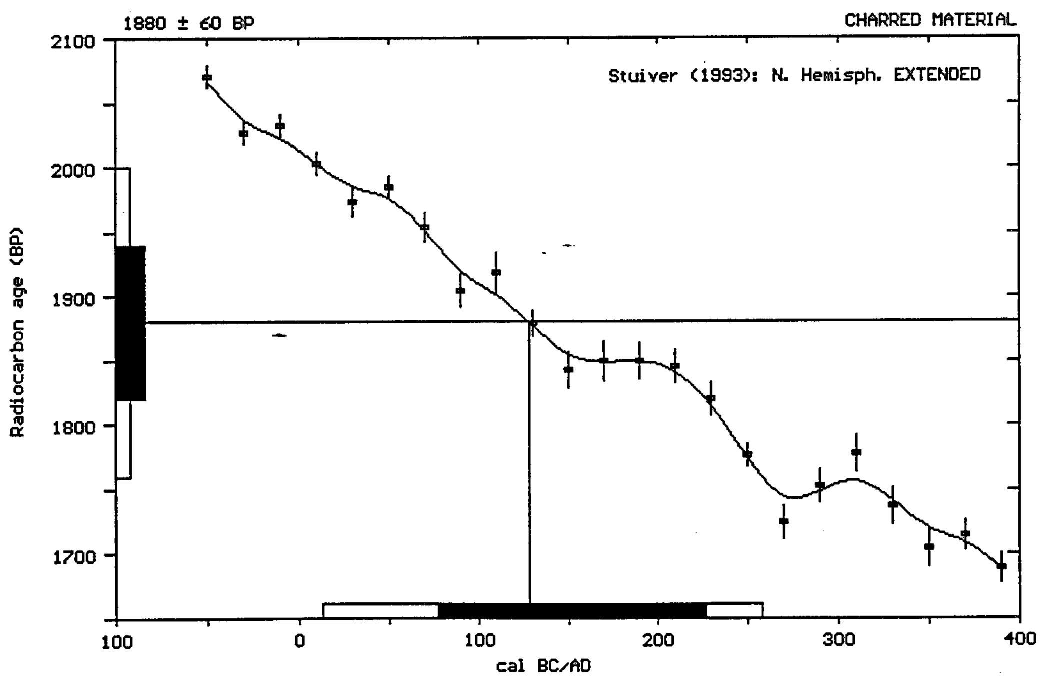
Conventional radiocarbon age: **1880 +/- 60 BP**

Calibrated results: **cal AD 15 to 260**
(2 sigma, 95% probability)

Intercept data:

Intercept of radiocarbon age with calibration curve: cal AD 130

1 sigma calibrated results: (68% probability) cal AD 75 to 225



References:
Vogel, J. C.,Fuls, A., Visser, E. and Becker, B., 1993, Radiocarbon 35(1), p73-86
Talma, A. S. and Vogel, J. C., 1993, Radiocarbon 35(2), p317-322
Stuiver, M., Long, A., Kra, R. S. and Devine, J. M., Radiocarbon 35(1)

Results prepared by:
Beta Analytic, Inc. 4985 S.W. 74th Court, Miami, Florida 33155

Appendix D
Pollen Analysis

A PALEOECOLOGICAL STUDY OF THREE SITES, LOCATED IN THE FORT LEONARD WOOD MILITARY RESERVATION, SOUTH-CENTRAL MISSOURI OZARKS

by

James K. Huber
Archaeometry Laboratory
214 Research Laboratory Building
University of Minnesota, Duluth
Duluth, Minnesota 55812

Report submitted to

Paul E. Albertson
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, Mississippi 39180

July 1994

Archaeometry Laboratory Report Number 94-8

A PALEOECOLOGICAL STUDY OF THREE SITES, LOCATED IN THE FORT LEONARD WOOD MILITARY RESERVATION, SOUTH-CENTRAL MISSOURI OZARKS

by

James K. Huber
Archaeometry Laboratory
214 Research Laboratory Building
University of Minnesota, Duluth
Duluth, Minnesota 55812

Report submitted to

Paul E. Albertson
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road
Vicksburg, Mississippi 39180

July 1994

Archaeometry Laboratory Report Number 94-8

A PALEOECOLOGICAL STUDY OF THREE SITES LOCATED IN THE FORT LEONARD WOOD MILITARY RESERVATION, SOUTH-CENTRAL MISSOURI OZARKS

James K. Huber

Abstract: Twenty samples from three sites on Big Piney River and Roubidoux Creek in the Fort Leonard Wood Military Reservation were analyzed for pollen. Although the pollen is too scarce to yield statistically valid pollen percentage data, the data is consistent with the Oak-Hickory-Pine forests characteristic of the south-central Missouri Ozarks.

i

INTRODUCTION

Palynology, the study of pollen and spores and their dispersal, has for many years been a primary tool for paleoecologists. Palynological data from bogs, marshes, and lakes are important in establishing past vegetational and climatic records (Kapp, 1969; Faegri and Iverson, 1975; Moore and Webb, 1978). In recent years, however, archaeologists have realized the importance of palynological investigations as part of multidisciplinary archaeological studies. The correlation of stratigraphically continuous pollen data with archaeological sites in the same area may yield valuable paleoenvironmental reconstructions for sites (King, 1985). Changes in both local and regional vegetation, as well as climate, may be very important in the interpretation of archaeological data (King, 1985). Palynological investigations can also be used to identify cultigens and wild plants gathered for food or raw materials; to obtain dietary information; to study site seasonality (King, 1985); and to determine potential resource plants (Huber, 1987).

In the past, paleoecological investigations have relied heavily on pollen as a primary indicator of environmental change. Plant macrofossils have also been used in conjunction with pollen studies (Huber, 1980; Van Zant, 1976, 1979; Watts and Bright, 1968; Watts and Winter, 1966). In subsequent years, more emphasis has been placed on the increased use of other organisms as paleoecological and paleoclimatic indicators (Williams, 1981); among these organisms are algae (Van Geel, 1986).

Previous subfossil algae studies have concentrated on *Pediastrum* associated with pollen. They were usually identified only to the genus level and presented as a percentage distribution of total *Pediastrum* (Cronberg, 1986). However, *Pediastrum* are readily preserved in sediments and can be easily identified to the species level. They can also survive rigorous pollen extraction techniques (Cronberg, 1986). In addition to *Pediastrum*; *Scenedesmus*, *Botryococcus*, and numerous other taxa of nonsiliceous algae can be recognized in subfossil records. Subfossil nonsiliceous algae found in conjunction with pollen can aid in paleoecological reconstructions (Cronberg, 1986).

The objectives of this study were to provide palynological data to aid in the development of a geoarchaeological model for Big Piney River and Roubidoux Creek in the south-central Missouri Ozarks for application to cultural resource management at the Fort Leonard Wood Military Reservation and to provide a more complete understanding of the late Holocene vegetational history of the area (Figure 1).

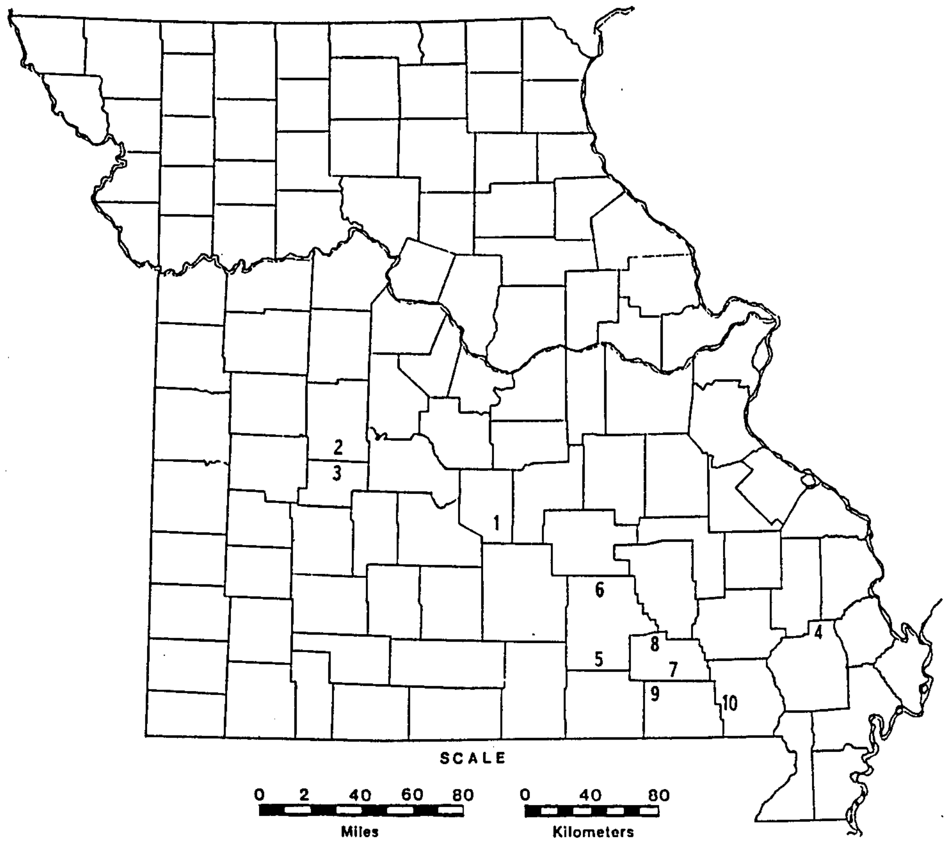


Figure 1: Location map of the Fort Leonard Wood area and localities of previous pollen investigations in Missouri.

Explanation

1. Fort Leonard Wood area
2. Boney and Phillips springs
3. Kirby, Jones, Trolinger, and Koch springs
4. Old Field Swamp
5. Buttonbush Bog
6. Round Spring Shelter, Round Spring Site 23SH19
7. Gooseneck Site 23CT54
8. Ozark Sink Pond
9. Cupalo Pond
10. Powers Fort Swale

PREVIOUS INVESTIGATIONS

The first palynological study in Missouri was of Boney Spring (Figure 1), Benton County (Mehringer, Schweger, Wood, and McMillan, 1968). Mehringer and others (1968) found a spruce-dominated pollen spectrum and associated it *Picea* (spruce) and *Larix* (tamarack) macrofossils. They interpreted the pollen spectrum as evidence for late Pleistocene boreal forest elements in the Ozark Highlands.

Mehringer, King, and Lindsay (1970) examined Boney Spring in more detail and examined Trolinger Spring, Hickory County (Figure 1). They recognized three pollen-assemblage zones from the combined data of the two sites. The three zones are generally characterized as a NAP-pine zone (NAP = nonarboreal pollen), a spruce-dominated zone, and a spruce-with-deciduous-elements zone. Radiocarbon dates from the NAP-pine zone at Trolinger Spring are approximately 25,600 B.P. and 32,200 B.P., suggesting mid-Wisconsin interstadial age. The spruce-dominated zone may indicate the beginning of late-Wisconsin full glacial conditions. Radiocarbon dates from Boney Spring are approximately 13,700 B.P. and 16,580 B.P., thus giving an approximate time frame for the spruce-with-deciduous-elements zone (Mehringer and others, 1970).

King (1973) subsequently examined Boney and Trolinger springs in addition to Kirby, Koch, and Jones springs, Hickory County (Figure 1) and again recognized the same three pollen-assemblage zones. Radiocarbon dates indicate the presence of a NAP-pine zone before 40,000 B.P. that existed until approximately 23,000

B.P. and was deposited during the mid-Wisconsin interstade. Cyperaceae (sedge) and *Pinus* (pine) make up at least 60% of the total pollen within this zone. Spruce is commonly found in quantities of less than 1%. Other arboreal pollen types include *Betula* (birch), *Quercus* (oak), and *Salix* (willow). Nonarboreal pollen includes Gramineae (grass), *Ambrosia*-type (ragweed), and other Compositae (Composite Family). This zone is interpreted as a pine-parkland (King, 1973).

Directly above the NAP-pine zone is the spruce pollen zone, dominated by up to 92% spruce and also containing some *Pinus* and Cyperaceae pollen. This zone began with the onset of late-Wisconsin full-glacial conditions. King (1973) interprets it as a boreal spruce forest that lasted until approximately 16,500 B.P.

A short hiatus separates the spruce zone from the spruce-with-deciduous-elements pollen zone, characterized by lower spruce percentages (less than 38%) and by an increase in thermophilous deciduous tree pollen. This zone is indicated by pollen found in pulp cavities of mastodon tusks recovered from Boney Spring. Spruce is still the dominant pollen type but *Pinus*, *Quercus*, *Salix*, *Alnus* (alder), *Fraxinus* (ash), *Ulmus* (elm), *Corylus* (hazel), and *Ostrya/Carpinus* (hop hornbeam/hornbeam) also occur. Most of the NAP is composed of Cyperaceae, Gramineae, and various composites. This zone is interpreted as a spruce forest with deciduous trees, indicating slightly warmer climatic conditions during a late phase of Wisconsin full-glacial conditions (King, 1973).

McMillan and King (1974) reported finding a Holocene pollen sequence in sediments from Phillips Spring, Benton County (Figure 1). The spring sediments contained pollen spectra that indicate a change from arboreal pollen dominance, primarily *Quercus*, to nonarboreal pollen dominance. Radiocarbon dating places this change at 7800 B.P. Dominance of nonarboreal pollen continues until at least 4000 B.P. (McMillan and King, 1974).

King and Lindsay (1976) reiterated the previously mentioned studies (King, 1973) and related the findings to archaeological deposits at Rodgers Shelter, Benton County, and to megafauna assemblages associated with the pollen deposits. King and Lindsay (1976: 76, Table 4.2) summarized the radiocarbon dates, flora, and fauna from Trolinger and Boney springs.

A pollen sequence from Cupalo Pond, Ripley County (Figure 1) investigated by Smith (1984) yielded a continuous record from full-glacial to the present. Five pollen-assemblage zones were delineated by Smith (1984). From 17,100 to 15,350 yr B.P. northern Diploxylon pine (jack and/or red pine) and spruce were dominant in the area. From 15,350 to 12,300 yr B.P., the upland vegetation was characterized by a transitional forest of *Quercus*, *Fraxinus*, *Pinus*, and *Picea*. Northern Diploxylon *Pinus*, *Picea*, and *Fraxinus* was replaced by the expansion of *Quercus*, *Carya* (hickory), and *Ostrya/Carpinus* and Compositae during the early Holocene (12,300-9100 yr B.P. Between 9100 and 6700 yr B.P., during mid-Holocene warming, species richness of deciduous taxa decreased. An oak parkland dominated the uplands between 6700 and 6350 yr B.P. The oak

parkland was replaced by a shortleaf pine (southern Diploxylon *Pinus*) forest by 3500 yr B.P.

At Powers Fort Swale (Figure 1), in the Western Lowlands of southeast Missouri, an 18,000 year record of vegetational change has been reported by Royall (1988) and Royall, Delcourt, and Delcourt (1991). The pollen sequence from Powers Swale is divided into four pollen zones. The lowermost is the *Picea-Pinus* zone (18,275-14,500 yr B.P.). The pollen spectra from this zone is similar to that of the spruce forest and muskeg in the boreal forest region found today in central and southern Canada. From 14,500 to 9500 yr B.P., a *Quercus-Carpinus-Ostrya* zone occurs indicating vegetation similar to that of the midwestern mixed-conifer northern hardwoods region. Above this zone is the *Quercus-Fraxinus* zone (9500-4500 yr B.P.). The *Quercus-Fraxinus* zone is characterized by climatic warming and drying, with a species composition similar to that found in the area today but with different relative abundance for each taxon. The uppermost zone is the Cupressaceae-*Salix* zone (4500-0 yr B.P. This zone is similar in to the modern vegetation at Powers Fort Swale today.

Old Field swamp, Stoddard County (Fig. 1) was cored and analyzed for pollen by King and Allen (1977). Two vegetation changes are indicated between 9000 and 3000 B.P. At approximately 8700 B.P., arboreal pollen composed largely of *Quercus*, *Fraxinus*, and *Cephalanthus* (buttonbush) was replaced with Gramineae and other NAP. A second change occurred at approximately 5000 B.P. when trees again began to increase. These changes are interpreted as reflecting

the expansion and subsequent reduction of the Prairie Peninsula in southeastern Missouri between 8700 and 5000 B.P. (King and Allen, 1977). Similar evidence for eastern expansion of the Prairie Peninsula has been found in pollen records from the northern midcontinent.

Watts and Bright (1968) record a shift to more prairie on the upland and a decrease in trees from a pollen sequence at Pickerel Lake, Day County, South Dakota between 8000 and 4000 B.P. At Kirchner Marsh, Dakota County, Minnesota, Winter (1962) also recorded an increase in nonarboreal pollen occurring between approximately 7200 and 5000 B.P. A migration of the prairie/forest ecotone of about 120 km northeastward occurred in western Minnesota between 8000 and 4000 B.P. (Wright, 1968). Brush (1967), Durkee (1971), and Van Zant (1976, 1979) record a shift from forest to prairie between 8000 and 3000 years ago in Iowa. In Illinois, E. Gruger (1972) recorded an undated rise in herb pollen and decrease in oak after the late Pleistocene spruce decline. Pollen records show that a mid-Holocene dry period lasting approximately 4000 years occurred between 8000 and 4000 years ago and reached maximum warm and dry conditions about 7000 B.P. (Webb and Bryson, 1972; Wright, 1971). At the same time the Prairie Peninsula reached its maximum eastward extent (Bernabo and Webb, 1977).

Buttonbush Bog, a small sinkhole bog in Shannon County (Figure 1) yielded a late Holocene vegetational record for the southeast Missouri Ozarks (Huber, 1990a). A 302-cm core retrieved from the bog has a basal date of 3130 yr B.P. and a date of 1400 yr B.P. at 52-56 cm. The pollen spectra from the core are

dominated by *Quercus*, *Pinus*, and Gramineae, with *Carya* maintaining low but consistent percentages. The pollen sequence is divided into three pollen-assemblage zones. Zone 1 (302-292 cm) is dominated by *Quercus*, Gramineae, and Cyperaceae. *Pinus* and *Carya* occur as minor components (<5%). In Zone 2 (292-17 cm), *Pinus* increases to codominate with *Quercus*. Gramineae and Cyperaceae are the major herbs and increase in abundance above 1400 yr B.P. Zone 3 (17-0 cm) is marked by a small *Ambrosia* rise. The pollen sequence from Buttonbush Bog indicates that pine did not become well established in this area of the southeast Missouri Ozarks until after 3100 B.P. Zone 1 represents a mixed oak forest with minor components of pine and hickory. In Zone 2, the increase in pine indicates a shift to a pine-oak forest, The increase in sedge and grass in Zone 2 may indicate an increase in available moisture after 1,400 yr B.P. The small *Ambrosia* rise in Zone 3 is attributed to the advent of pioneer settlement in the area about 1820 (Huber, 1990a).

Huber and Rapp (1989) undertook palynological investigations of two archaeological sites: Round Spring Shelter, Round Spring Site 23SH19 and Gooseneck Site 23CT54 in Shannon and Carter counties, Missouri (Figure 1). The palynological data from these sites provide vegetational histories associated with Indian occupation. The Round Spring Shelter pollen sequence is dominated by *Quercus* and Tubuliflorae (subfamily of Compositae. NAP is greater than 50% of the pollen sum in all but the uppermost sample interval where it decreases to 47.4%. Two *Ambrosia* peaks in the pollen diagram from Round Spring. The upper

rise is attributed to land clearance and pioneer settlement (King, 1981; Huber, 1980, 1985, 1987; Van Zant, 1976, 1979). This *Ambrosia* rise is accompanied by a decrease in *Quercus*, also indicating clearing of the forest for lumber and field cultivation. The lower *Ambrosia* rise, however, may indicate a prolonged period of occupation of Round Spring Site 23SH19. Huber and Rapp (1989) divided the pollen diagram from Round Spring Shelter into two zones. Zone 1 (the lowermost zone) is characterized by an *Ambrosia* rise and by a decline in Chenopodiaceae/Amaranthaceae (Goosefoot/Amaranth families), Cyperaceae, Gramineae, *Fraxinus quadrangulata*-type (blue ash), and *Pinus* towards the top, at the same time that *Juniperus*-type (red cedar), *Dryopteris*-type (shield fern), and *Lycopodium* (clubmoss) increase. Zone 2 contains the second *Ambrosia* rise and is characterized by a decline in Tubuliflorae and an increase in *Pinus*. *Carya*, and the herbs Chenopodiaceae/Amaranthaceae, Cyperaceae, and Gramineae all increase towards the top of this zone. *Lycopodium* and *Dryopteris*-type also rise, but *Juniperus*-type declines slightly. Based on associated Middle Woodland artifacts, the Round Spring pollen sequence begins about 2450 yr B.P. and continues to the present, assuming that the upper *Ambrosia* rise is the result of land clearance and pioneer settlement. The Round Spring Shelter pollen is interpreted as representing a pine-oak forest growing in the vicinity of Round Spring Site 23SH19 with ferns growing in the cooler, moister area near the spring. The consistent presence of *Ambrosia* and other weedy plants probably represents disturbance created by Indian occupation at the site. The high Tubuliflorae values in the pollen spectra

may reflect gathering or cultivation of sunflower and/or marsh elder or both during Indian occupation of the site.

Huber and Rapp (1989) also analyzed eight archaeological sediment samples from Gooseneck Site 23CT54 for pollen content. Gooseneck Site 23CT54 is an Early Mississippi Naylor Phase site and may represent a small hamlet dating from ca. 1050-750 yr B.P. *Quercus* is the most consistent dominant pollen type in the pollen spectra from the Gooseneck Site 23CT54 samples. Other important taxa include: *Carya*, *Pinus*, *Fraxinus*, and *Ambrosia*-type). *Zea mays* (corn), which occurred in seven of the eight samples and was identified solely by grain size. The pollen spectra from the eight Gooseneck Site 23CT54 samples is interpreted as representing a mixed oak-hickory forest growing in the uplands near the site and ash, willow, grape, elm, walnut, hickory, and tupelo growing in the river bottoms.

Six bryophyte polsters, which are clumps of moss resembling a cushion (Hanson, 1962), were analyzed by King (1973) as part of his study in the western Missouri Ozarks for modern pollen rain. Three samples were collected from the oak-hickory forests near Trolinger Spring, Hickory County and Boney Spring and Rodgers Shelter, Benton County. In Shannon County three polsters were collected from pine-oak forests at Round Spring State Park, Alley Spring State Park, and a native pine area 10 km north of Eminence, Missouri. The oak-hickory sites have up to 30% *Quercus* and high values of *Ambrosia*-type pollen (up to 40%) that may reflect abandoned farmland in the area (King, 1973). Pine values are low, less than 5%. Ash values are approximately 15%. At the pine-oak sites, pine values

reach 30%, oak 40%, and ash 15%. There is less NAP pollen at the pine-oak sites than at the oak-hickory sites (King, 1973).

Peterson (1978) analyzed 29 samples of surface sediments from lakes and ponds in Illinois, Missouri, and Kentucky for modern pollen rain. Seven of his sites occur in Missouri. Based on his data, Peterson (1978) presented isopoll maps for four pollen taxa, *Quercus*, *Ambrosia*, *Carya*, and *Ulmus*. The maps indicate values of approximately 30% for *Quercus* and *Ambrosia* and 3% for *Carya* and *Ulmus*. These values are calculated as a percent of the pollen sum, which excludes spores, aquatics, and unidentified grains (Peterson, 1978).

Seven bryophytic polsters and three samples of surface soil from near an Ozark sink pond and the Gooseneck Site 25CT54 in Carter County, and near Buttonbush Bog and Round Spring Site 23SH19 in Shannon County were analyzed by Huber (1990b) for modern pollen rain (Figure 1). He found that the modern pollen spectra has high percentages (60 to 90%) of AP and that NAP is highest at Round Spring (36.5%). *Quercus* is the dominant pollen type, ranging from 29 to 67% with a regional average of 51.5%. *Pinus* values range from 8.5 to 32%; the lowest occurring at Ozark Sink Pond. At all localities, *Fraxinus* values are less than 7%. *Carya* ranges from 1 to 4% except in one sample from Gooseneck, where *Carya* reaches 17%. *Salix* and *Ulmus* pollen is present at less than 1.5% each and Cupressaceae (red cedar/white cedar) has a maximum value of 4%. *Ambrosia*-type pollen varies from 3.6 to 15% and is highest at Buttonbush Bog. Gramineae values are below 5% and Chenopodiaceae/Amaranthaceae values are less than 1%

at all sites. Pollen values of Cyperaceae range from less than 1% to almost 11%. Huber (1990b) found that the dominant taxa in the modern pollen rain show a similar trend in relative importance to the dominant forest cover based on the commercial growing stock data of Mendel (1961).

See Royall (1988:107) and Royall, Delcourt, and Delcourt (1991:167) for a correlation chart of age, climate, and vegetational history of the Ozark Plateau, Western Lowlands, and Eastern Lowlands of Missouri.

SITE DESCRIPTION

Fort Leonard Wood Military Reservation encompasses most of the southeast quarter of Pulaski County. Roubidoux Trench 1 (RT1) and Roubidoux Trench 2 (RT2) are located on Roubidoux Creek. The Happy Hollow Borehole 17 (HH17) is located on the Big Piney River.

Floristically, the study locality is located in Steyermark's (1963) Ozark Region and more specifically in Küchler's (1964) oak-hickory-pine forest. Characterized by a diversified flora, the Missouri Ozark Region contains the greatest number of species of any part of the state (Steyermark, 1963). Many microclimates and microenvironments occur within this area, each possessing a characteristic assemblage of plants (Huber and Rapp, 1981; revised 1983).

The Ozark Region forest flora is pine-oak and oak-hickory woodlands. Although the Ozark forests are considered to be oak-hickory-pine forest (Küchler, 1964) or pine-oak and oak-hickory (Steyermark, 1963), hickory is a relatively minor element (King, 1973). The forest flora with its herbaceous components belong to a Carolinian flora (Dice, 1943; Steyermark, 1963) with a slight dominance of southern species, floristically intermediate between austral and boreal phases. The upland herbaceous species are usually plants that range from the Appalachian plateau to the grassy plains (Steyermark, 1963).

Vaccinium vacillans (lowbush blueberry) is the dominant understory on acid soils. Limestone-derived soils have floras consisting of *Blumelia* sp. (southern buckthorn), *Ilex decidua* (deciduous holly), *Tilia americana* (linden), *Juglans nigra*

(black walnut), *Asimina triloba* (pawpaw), *Quercus prinoides* var. *acuminata* (chinquapin oak), *Fraxinus quadrangulata*, *Acer saccharum* (sugar maple), and other forest species (Steyermark, 1963).

Several herbaceous plants have their closest associations with southern coastal plain species. Other species are usually found in a more northern boreal habitat and represent relict species that have survived in the Ozarks since the retreat of the Laurentide ice sheet. Many plants that have rare and isolated occurrences are at or near the limits of their geographic range (Steyermark, 1963).

The Ozark region has never been glaciated and thus has been open for migration since Tertiary times. Some species are restricted to the eastern, western, or southern edges of the region whereas others are widespread throughout. The southeastern Ozark Region is characterized by flora with an Alleghenian relationship. Many southwestern, southern, or western species are found on exposed south- and west-facing slopes. In the deeply eroded V-shaped valleys and north-facing bluffs, many of the more northern ranging species occur (Steyermark, 1963).

The Ozarks have been divided into two sections by Braun (1950): the Interior Highlands and the Forest-Prairie Transition. The Interior Highlands include Shannon and Carter counties and contain the bulk of the Ozark oak-hickory forest. In this area, oaks codominate with yellow or shortleaf pine (*Pinus echinata*) and locally may form pure stands (Braun, 1950). Mature stands of shortleaf pine occur

in only a few localities in the southeastern Ozarks and the Missouri-Arkansas border (Critchfield and Little, 1966: map 42).

Steyermark (1940) further subdivides the Ozark oak-hickory forests into five edaphic associations based on physical, chemical, and local moisture conditions:

1. Sugar Maple-Bitternut Hickory Association (*Acer saccharum-Carya cordiformis*)
2. Sugar Maple-White Oak Association (*Acer saccharum-Quercus alba*)
3. Oak-Hickory Association (*Quercus-Carya*)
4. Oak-Pine Association (*Quercus-Pinus echinata*)
5. White Oak-Red Maple Association (*Quercus alba-Acer rubrum*)

This description of the Ozark flora can only be applied as a generalization. In several areas of the Missouri Ozarks, prairie flora inhabit forest openings and glades (Braun, 1950; Steyermark, 1963). The distribution and composition of the Ozark's modern flora described by Steyermark (1940, 1959, 1963) is probably not the same as it was at the advent of European settlement. Sauer (1920:59) reports the following changes in the Ozark forests:

1. greater density of stand and more undergrowth, resulting from the cutting of large timber and the cessation of fires;
2. a great decrease in the lowland forest area as a result of land clearance for farming; and
3. a relative increase of those species that have the most efficient means of propagation, such as oaks and elms with their coppicing habits and, in the bottoms, the sycamore and cottonwoods with wind-blown seeds.

Beilman and Brenner (1951a, 1951b) believe the Ozark oak-hickory forests are a relatively recent development and are still maturing. Steyermark (1959)

disagrees, feeling that the present oak-hickory forests were derived from widespread mixed Tertiary forests as a result of decreased available moisture. The palynological studies by Mehringer and others (1968, 1970), King (1973), King and Lindsay (1976), Huber (1987), and others substantiate Beilman and Brenner's (1951a, 1951b) belief that the Ozark oak-hickory forests are a relatively recent development. King and Lindsay (1976) suggest that the present oak-hickory forests did not become established in the western Missouri Ozarks until after 10,000 B.P.

PALYNOMORPH ANALYTICAL METHODS

Twenty samples were analyzed for pollen and other palynomorphs. The pollen samples were treated with a modified Faegri and Iverson (1975) technique (addition of KOH, HCl, HF, and acetolysis), sieved through seven μm Nitex screens (Cwynar, Burden, and McAndrews, 1979), stained with safranin and stored in silicone oil for counting. In addition, one standard *Eucalyptus* tablet was added to each sample in order to determine pollen concentration values (Maher, 1972). The depth and weight of each sample analyzed is shown in Table 1.

TABLE 1: FORT LEONARD WOOD POLLEN SAMPLES ANALYZED.

Roubidoux Trench 1		Roubidoux Trench 4		Happy Hollow Borehole 17	
Depth in inches	Sample weight (grams)	Depth in inches	Sample weight (grams)	Depth in inches	Sample weight (grams)
3-6	8.4	3-5	8.8	48-58	8.7
10-14	8.4	19-21	8.1	52-54	8.6
18-22	8.5	35-27	7.4	56-58	8.1
26-30	8.2			60-62	8.3
34-38	8.7			64-66	8.7
42-46	8.5			69-71	8.4
50-54	8.4			73-75	8.6
58-62	8.7			77-79	9.1
67-70	8.8				

A minimum of 300 grains of trees, shrubs, herbs and vascular cryptogams was identified and counted within the pollen sum for samples RT1 (3-6") and RT4 (3-5"). Indeterminable, unknown, and aquatic pollen, moss spores, nonsiliceous algae, pre-Quaternary fossils, and *Eucalyptus* spike grains were counted but not included in the pollen sum. In all the rest of the samples and pollen is very scarce. Therefore, statistically valid pollen counts could not be undertaken. However, transects of covering the entire area of each slide were done in order to obtain numerical presence data. All palynomorphs encountered were identified and counted.

During pollen counting of the RT1 (3-6") and RT4 (3-5") samples, the first transect was counted two mm from the south edge of the microscope slide. Subsequent spacing of the transects was estimated to cover the slide at approximately equal intervals from south to north. The interval estimations were done to minimize errors associated with nonrandom distribution of palynomorphs. When the 300 sum was reached, pollen counts were continued to the end of the transect, thus completing the count. All pollen on the entire microscope slide was counted for the rest of the Fort Leonard Wood pollen samples. After completing the counts the microscope slide was then sealed and placed on permanent file at the Archaeometry Laboratory, where original copies of the pollen count sheets are also on file.

Although no formal seed analysis was undertaken on the Fort Leonard Wood samples, a few seeds were recovered during the large particle fraction (>500 μm) separation. The seeds recovered were identified and counted by Seppo H. Valppu, Archaeometry Laboratory, University of Minnesota, Duluth where original copies of the seed count sheets are on file.

LOSS-ON-IGNITION OF ORGANIC AND CARBONATE CARBON METHODS

In order to obtain a more complete understanding of the depositional record, loss-on-ignition of organic and carbonate carbon was undertaken on the Fort Leonard Wood sediments. Carbonate and organic carbon content provide an independent means of interpreting the stratigraphic sequence which in turn can be correlated with the pollen assemblages. Changes in the carbonate and organic carbon content of sediment may also indicate environmental changes occurring in the watershed and the catchment basin through time. This information can be used to reconstruct past paleoenvironmental conditions.

The same intervals used for pollen sampling were used to measure weight percent loss-on-ignition to determine the proportions of organic and carbonate carbon. The Fort Leonard Wood samples were analyzed according to Dean's (1974) loss-on-ignition technique. Samples were dried at 90-100°C to determine dry weight. Percent loss-on-ignition was determined by combustion at 550°C for 1 hr for organic carbon and at 1,000°C for 1 hr for carbonate carbon content.

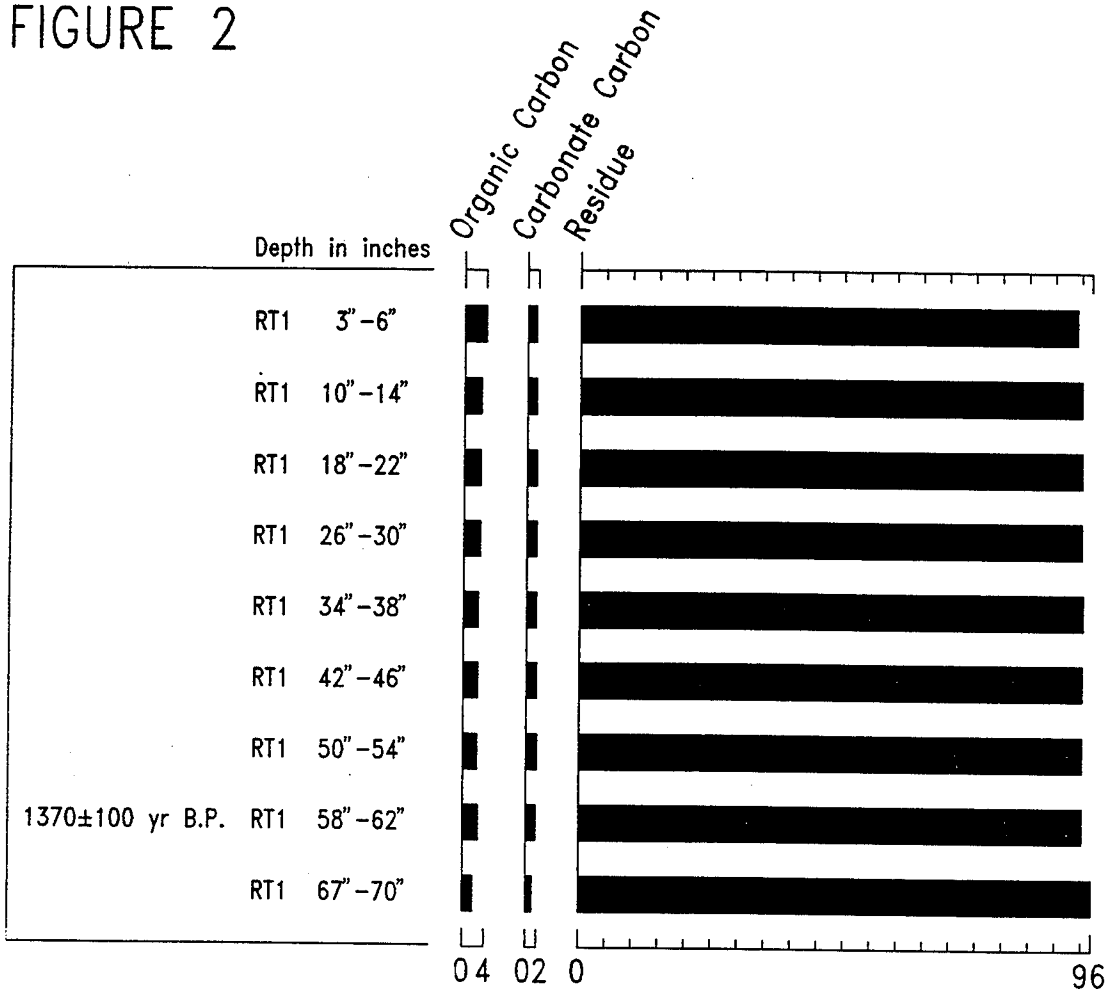
RESULTS

LOSS-ON-IGNITION OF ORGANIC AND CARBONATE CARBON METHODS

Organic carbon content in all the Fort Leonard Wood samples is low, 4% or less. Organic carbon varies from 2% to 4% in the RT1 and RT4 and from 1.5% to 2.0% in the HH17. At all sites there is a slight increase in organic carbon content upwards Figures 1-3). Carbonate carbon content is also very low, 2% or less at all sites, ranging from 1-2% at RT1 and RT4 (Figures 1-2). At HH17, carbonate carbon content is approximately 1% throughout the core (Figure 3).

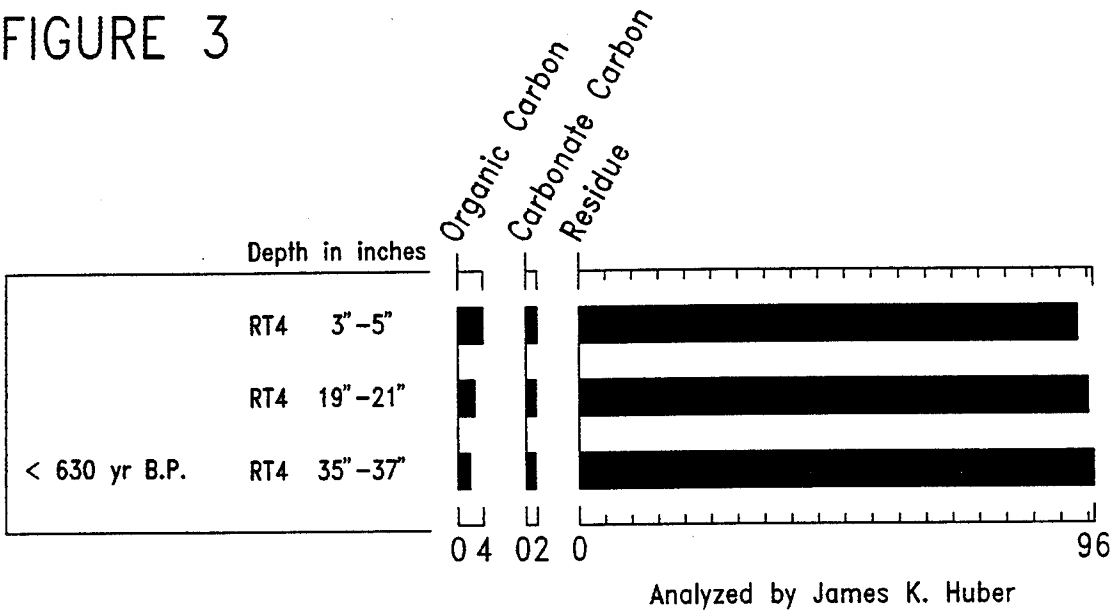
The Fort Leonard Wood organic carbon and carbonate carbon values are similar to the terrace deposits of the Current River at the Gooseneck Site 25CT54 in Carter County, Missouri (Huber, 1987). The low organic carbon content of the samples is probably the result of oxidation of organic materials. Most of the indeterminable degraded pollen grains appear to be oxidized and is consistent with the low organic carbon content. Loss-on-ignition values of less than 5% for carbonate carbon may indicate the removal of OH ions from clays between 550-1000°C rather than the presence of carbonates (Dean, 1974).

LOSS-ON-IGNITION PERCENTAGE DIAGRAM
ROUBIDOUX TRENCH 1
PULASKI COUNTY, MO
FIGURE 2

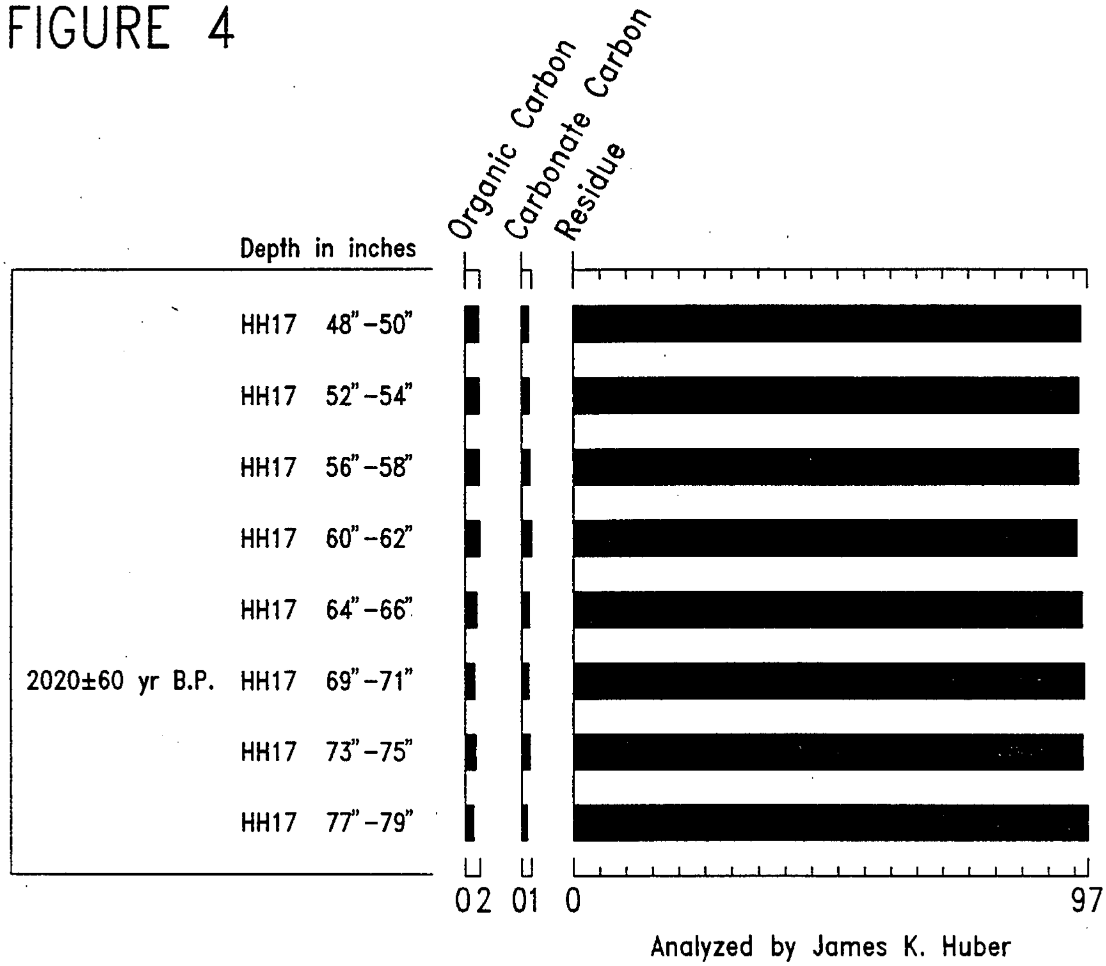


Analyzed by James K. Huber

LOSS-ON-IGNITION PERCENTAGE DIAGRAM
ROUBIDOUX TRENCH 2
PULASKI COUNTY, MO
FIGURE 3



LOSS–ON–IGNITION PERCENTAGE DIAGRAM
HAPPY HOLLOW 17
PULASKI COUNTY, MO
FIGURE 4



POLLEN

By convention, most pollen diagrams are expressed as percentage and concentration diagrams and divided into pollen assemblage zones, stratigraphic intervals that have some degree of internal consistency (King, 1981). However, pollen preservation in all but the RT1 (3-6") and RT4 (3-5") samples is extremely poor and pollen is very scarce. Therefore statistically valid pollen counts could not be undertaken for 18 of the 20 samples. In the absence of statistically valid data, the pollen diagrams for RT1, RT4, and HH17 are expressed as number of grains counted rather than by conventional pollen percentage diagrams. Pollen concentration data for the Fort Leonard Wood samples are expressed as conventional pollen concentration diagrams (grains/gram). In addition to the numerical diagrams, a pollen percentage diagram for the RT1 (3-6") and RT4 (3-5") samples has been constructed.

Roubidoux Trench 1:

Pollen sum counts varied from 4-320 grains/slide. Within the pollen sum, 23 taxa are represented and the number of taxa/sample ranged from 3 to 24 (Figure 5). Aquatics, mosses, and algae are represented by one taxon in each category. Although several types of fungal spores were observed, only one taxon was identified and counted. Indeterminable pollen consists of both degraded and broken grains. The total number of different taxa identified and counted is 38.

Pollen concentration in RT1 is low. RT1 (3-6") has a pollen sum concentration of 6690 grains/gram dry sediment and total fossil palynomorph concentration of 7235 grains/gram dry sediment. Subsequent pollen concentration data will be expressed as dry sediment. Pollen sum concentration of the lower eight RT1 samples varied from 85-585 grains/gram and total fossil palynomorph concentration ranged from 145-860 grains/gram. The lowest pollen sum and total fossil palynomorph concentration occurred RT1 50-54".

Quercus is the most consistent tree pollen type present in the RT1 column. Other trees present include *Pinus*, Cupressaceae, *Ulmus*, *Fraxinus quadrangulata*-type, *Fraxinus pennsylvanica/F. americana*-type (red/white ash), *Juglans nigra*, *Carya*, *Ostrya/Carpinus*, *Populus* (poplar), *Castanea* (chestnut), and *Nyssa* (tupelo). *Salix* and *Cornus* (dogwood) are the only shrubs present (Figure 5).

Present in all RT1 samples is *Ambrosia*-type pollen. *Ambrosia*-type pollen accounts for approximately one-half of the pollen sum in RT1 (3-6"). Other NAP present is *Artemisia* (wormwood), Tubuliflorae, Liguliflorae (subfamily of Compositae), Chenopodiaceae/Amaranthaceae, Cyperaceae, Umbelliferae (Parsley Family), and Gramineae (Figure 5).

Dryopteris-type, *Dryopteris Thelypteris* (marsh fern), *Pteridium*-type (bracken fern), *Pteridium aquilinum* (bracken fern), *Lycopodium*, *Lycopodium clavatum* (running clubmoss), *Lycopodium complanatum*-type (ground cedar), *Botrychium* (grape fern), and *Osmunda* (royal fern) are the vascular cryptogams occurring in

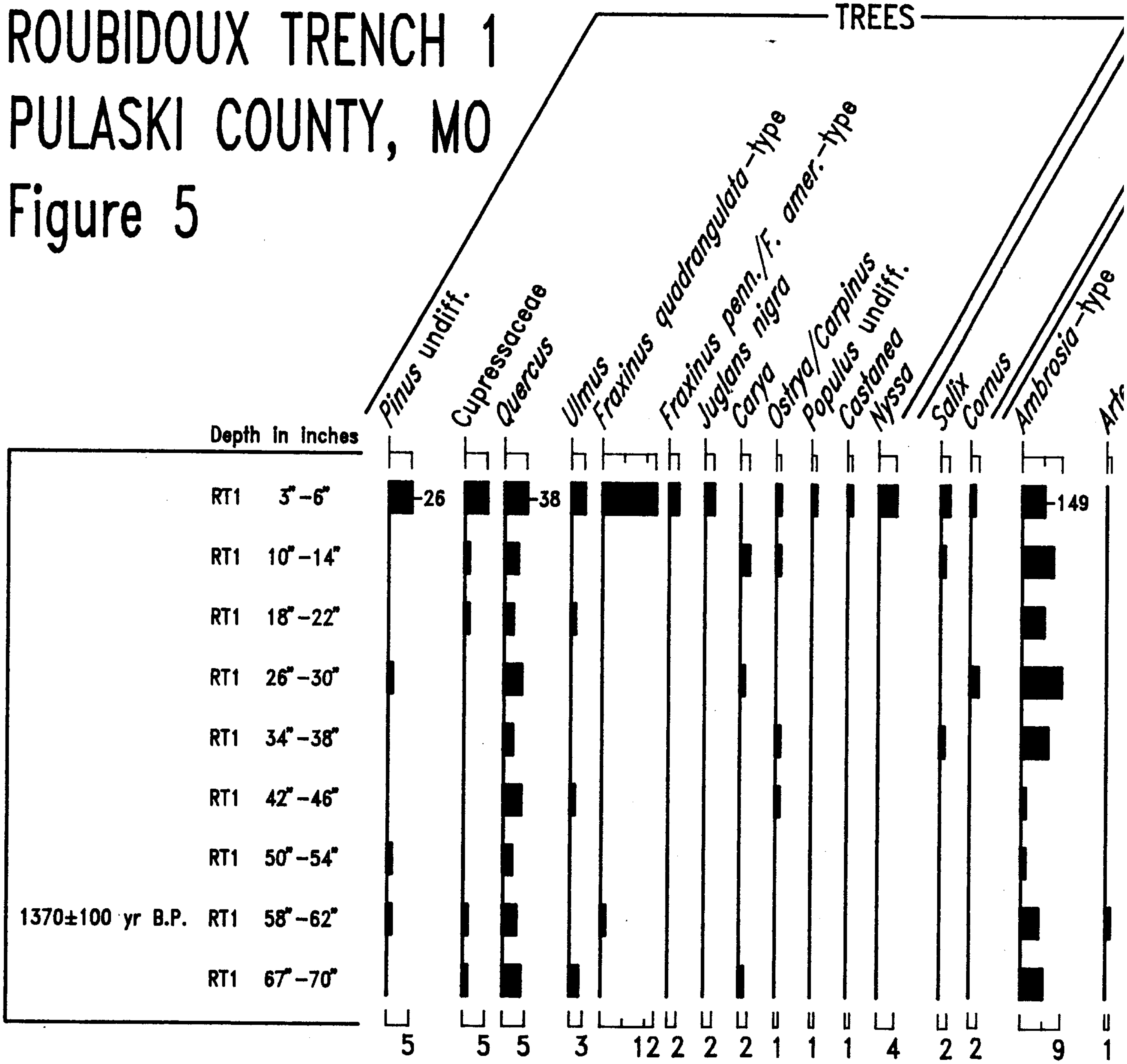
the RT1 sequence. Spores of *Lycopodium* sp. are the most abundant types present (Figure 5).

Spores of the aquatic *Isoetes* (quillwort), *Sphagnum* (sphagnum) moss spores, *Zygnema*-type resting spores of the green algae (Chlorophycophyta), and fungal hypodia of *Gaeumannomyces* cf. *caricis* were also found. Indeterminable degraded grains are very common throughout the RT1 sequence, indeterminable broken grains also occur (Figure 5).

In addition to pollen, seeds were also recovered from the RT1 (3-6") pollen sample (Figure 5). The seed types recovered are: oblong-type Compositae, *Oxalis stricta* (yellow wood sorrel), lenticular-type *Scirpus* (bulrush), *Mentha* sp. (mint), and *Solanum* cf. *nigrum* (black nightshade).

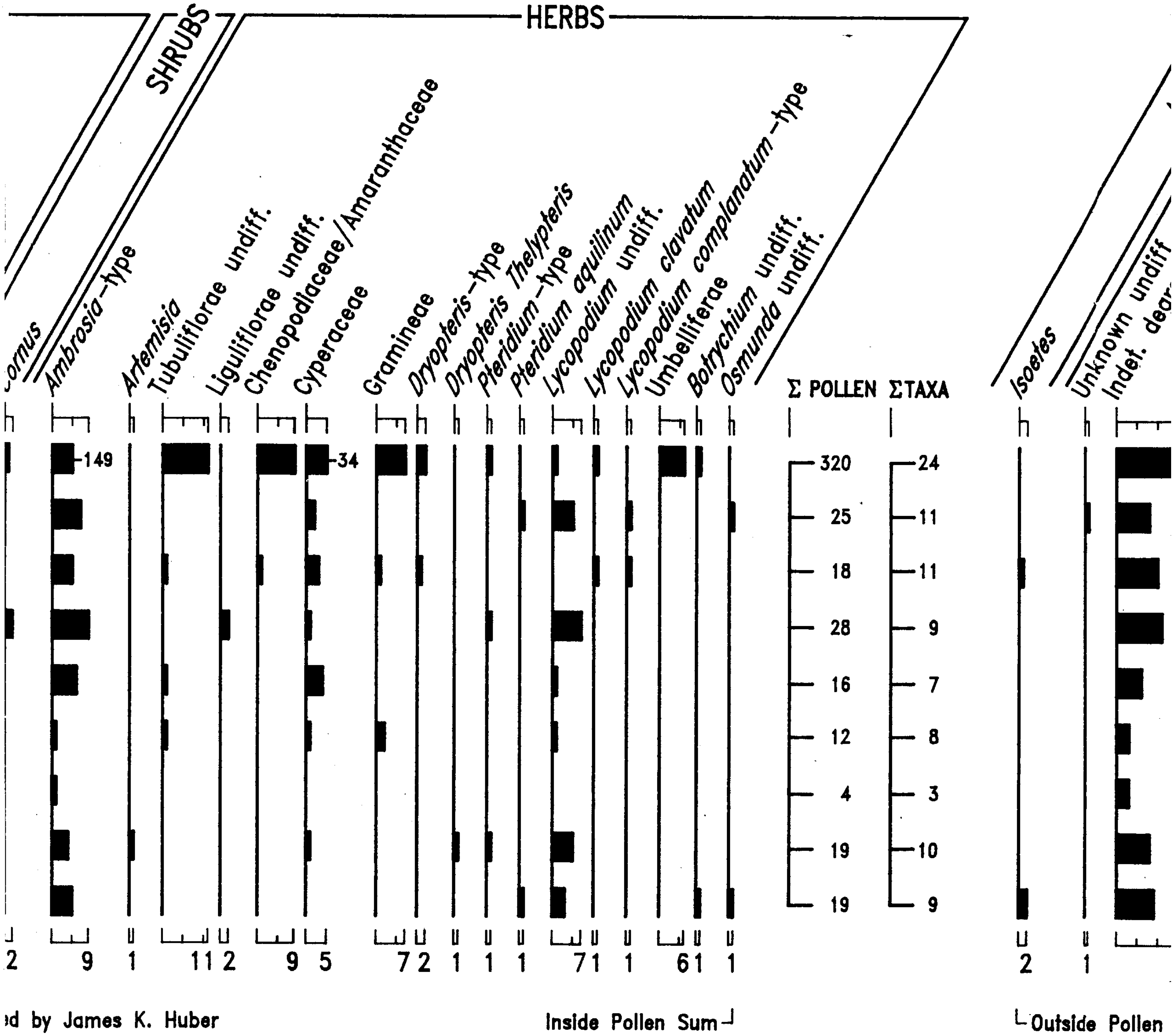
Pollen concentration for selected RT1 taxa are shown in Figure 6. *Quercus* pollen concentration ranges from 25-795 grains/gram. *Pinus* has a maximum concentration of 550 grains/gram. Cupressaceae and *Ulmus* have maximum concentrations of 105 and 62 grains/gram, respectively. *Ambrosia*-type pollen concentration varies from 22-3115 grains/gram. Present in seven of the RT1 samples, Cyperaceae pollen concentration ranges from 10-710 grains/gram. Chenopodiaceae/Amaranthaceae has a maximum pollen concentration of 190 grains/gram. Indeterminable degraded pollen concentration ranges from 65-480 grains/gram.

POLLEN, ALGAE, AND SEED DIAGRAM
ROUBIDOUX TRENCH 1
PULASKI COUNTY, MO
Figure 5

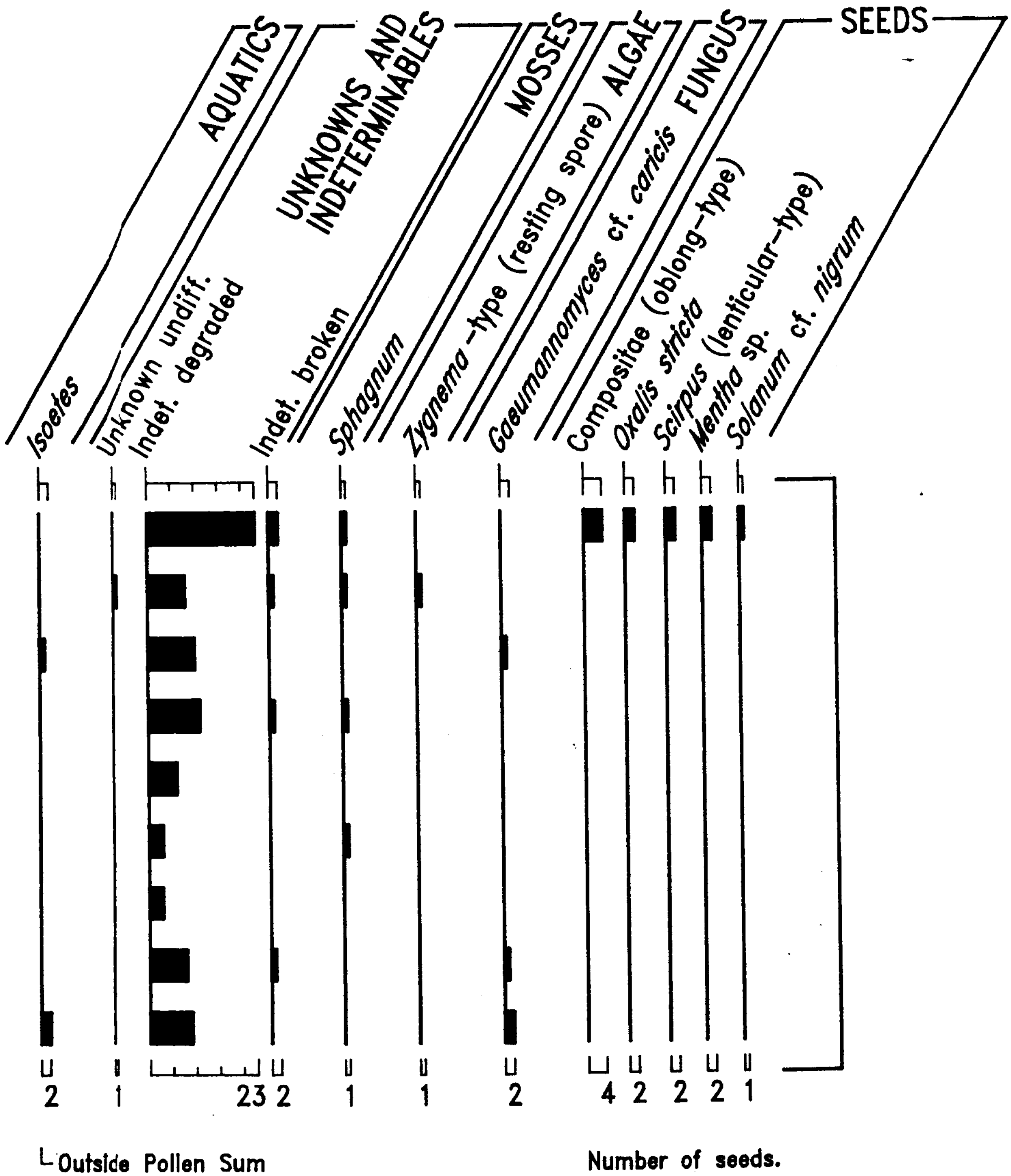


Number of pollen grains.

Analyzed by James K

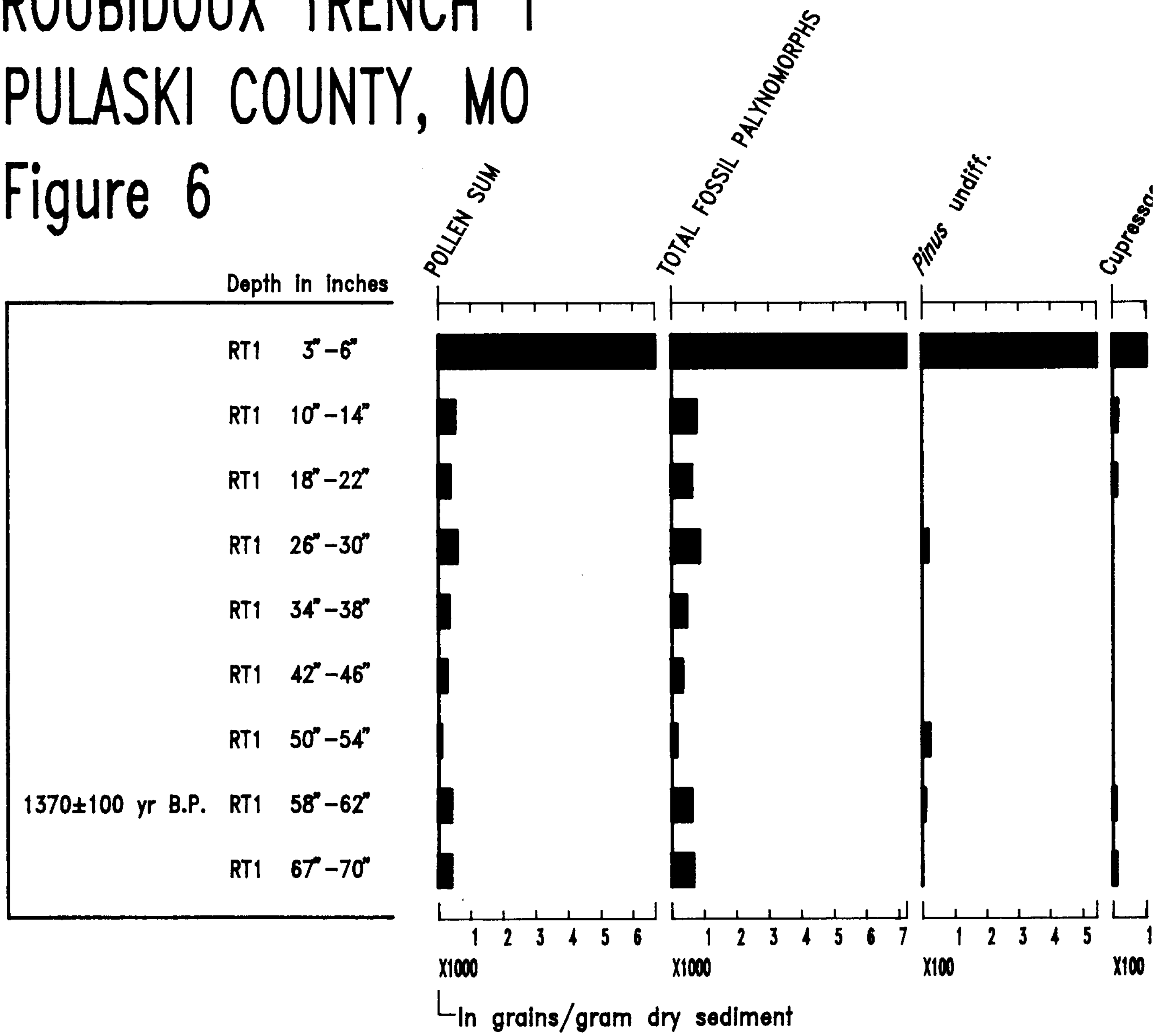

HERBS
SHRUBS
Ambrosia-type
Artemisia
Tubuliflorae undiff.
Liguliflorae undiff.
Chenopodiaceae/Amaranthaceae
Cyperaceae
Gramineae
Dryopteris-type
Dryopteris Thelypteris
Pteridium-type
Pteridium aquilinum
Lycopodium undiff.
Lycopodium clavatum
Lycopodium complanatum-type
Umbelliferae
Botrychium undiff.
Osmunda undiff.
Σ POLLEN
ΣTAXA
Isoetes
Unknown undiff.
320
25
18
28
16
12
4
19
19
24
11
11
9
7
8
3
10
9
149
34
2 9 1 11 2 9 5 7 2 1 1 1 7 1 1 6 1 1
2 1
by James K. Huber
Inside Pollen Sum
Outside Pollen

7

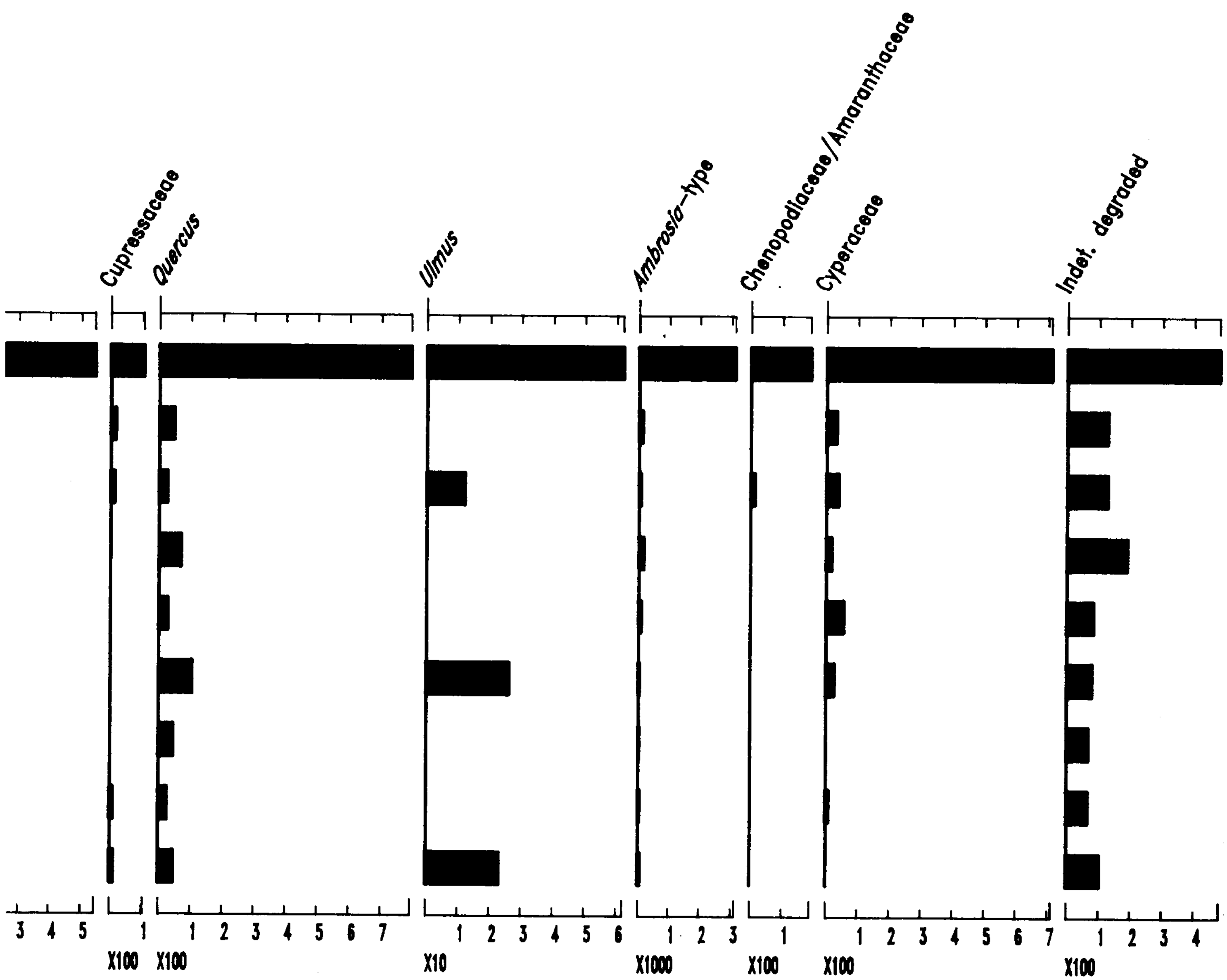

AQUATICS
UNKNOWNS AND INDETERMINABLES
MOSSES
ALGAE
FUNGUS
SEEDS
Isoetes
Unknown undiff.
Indet. degraded
Indet. broken
Sphagnum
Zygnema-type (resting spore)
Gaeumannomyces cf. caricis
Compositae (oblong-type)
Oxalis stricta
Scirpus (lenticular-type)
Mentha sp.
Solanum cf. nigrum
2
1
23
2
1
1
2
4
2
2
2
1
Outside Pollen Sum
Number of seeds.

POLLEN CONCENTRATION DIAGRAM OF SELECTE
ROUBIDOUX TRENCH 1
PULASKI COUNTY, MO

Figure 6



ELECTED TAXA



Note -- Scales differ between taxa.

Analyzed by James K. Huber

Roubidoux Trench 4:

Pollen sum counts varied from 25-303 grains/slide. Within the pollen sum, 34 taxa are represented and the number of taxa/sample ranged from 11 to 29 (Figure 7). Aquatics, mosses, and algae are represented by one taxon in each category. Only one taxon was identified and counted, although several types of fungal spores were observed. Indeterminable pollen consists of both degraded and broken grains. The total number of different taxa identified and counted is 35.

Pollen concentration in RT4 is also low. RT4 (3-5") has a pollen sum concentration of 2395 grains/gram and total fossil palynomorph concentration of 2830 grains/gram. Pollen sum concentration of the lower two RT4 samples are 225 grains/gram (19-21") and 200 grains/gram (35-37"). Total fossil palynomorph concentration is 380 grains/gram for RT4 (19-21") and 315 grains/gram for RT4 (35-37").

Pinus, *Quercus*, *Ulmus*, and *Fraxinus quadrangulata*-type pollen is consistently present throughout the RT4 sequence. Other trees present include Cupressaceae, *Tilia*, *Juglans nigra*, *Carya*, *Ostrya/Carpinus*, *Populus*, *Platanus* (sycamore), *Betula*, and *Celtis* (hackberry). *Salix* occurs in all RT4 samples; the shrubs *Corylus* and *Alnus* are also present (Figure 7).

NAP pollen types occurring in all RT4 samples are *Ambrosia*-type, Chenopodiaceae/Amaranthaceae, and Cyperaceae (Figure 7). Other NAP present is *Artemisia*, Tubuliflorae, Liguliflorae, *Sarcobatus vermiculatus* (greasewood),

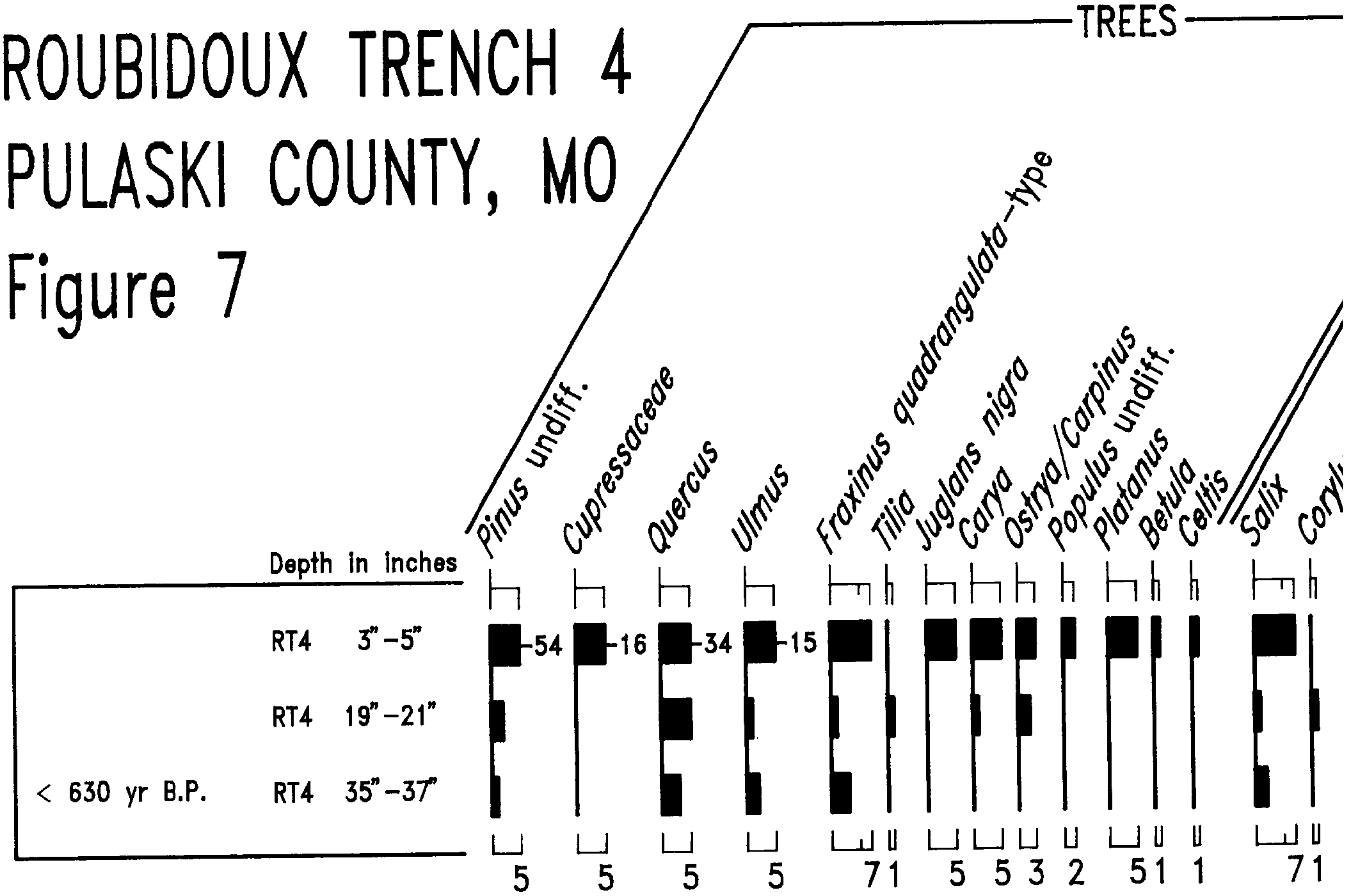
Gramineae, *Galium* (bedstraw), Umbelliferae, Caryophyllaceae (Pink Family), and Cruciferae (Mustard Family).

Dryopteris-type, *Pteridium*-type, *Lycopodium*, *Lycopodium clavatum*, *Lycopodium complanatum*-type, and *Equisetum* (horsetail) are the vascular cryptogams occurring in the RT4 palynomorph spectra. Spores of *Lycopodium* sp. are the most abundant types present (Figure 7).

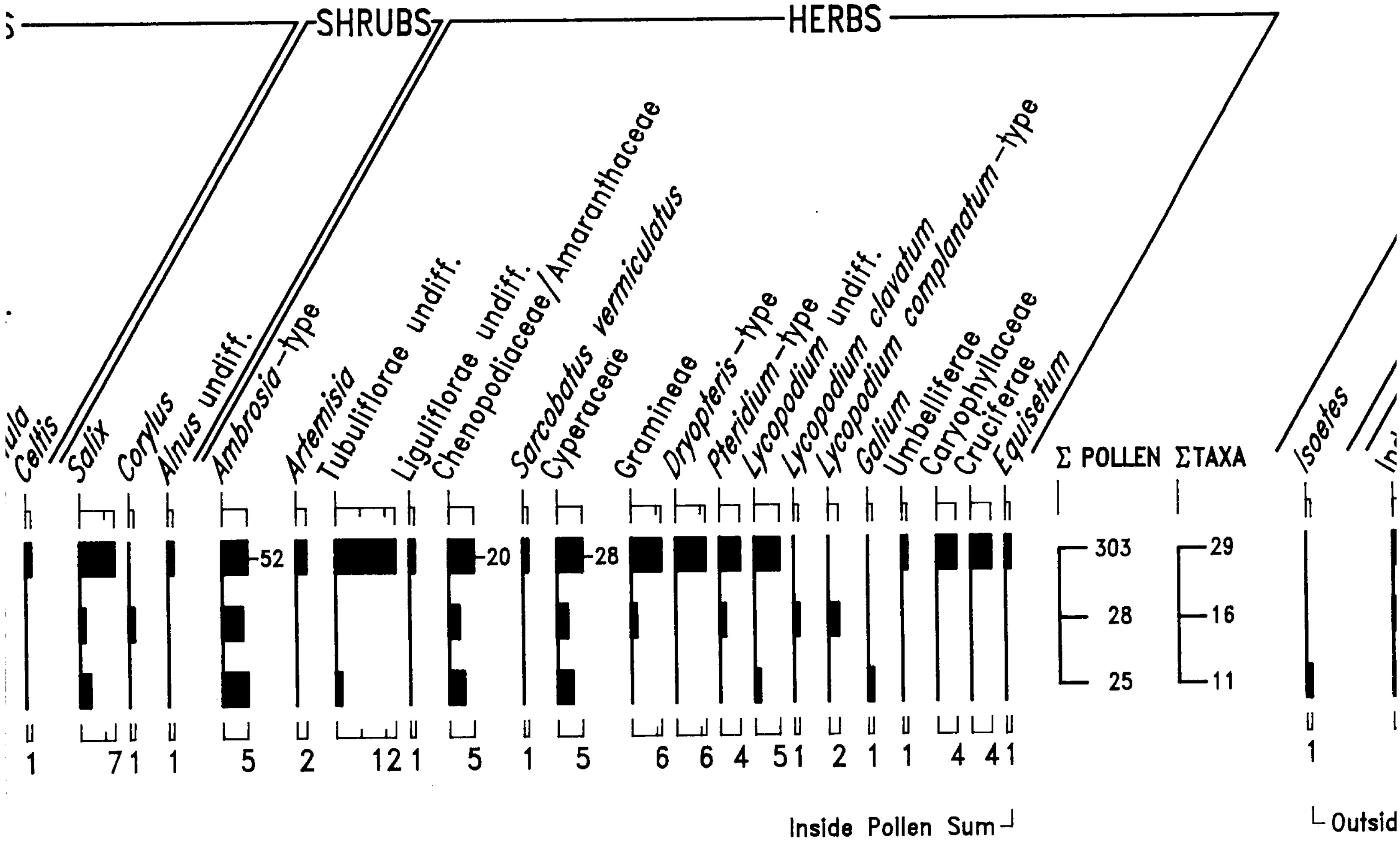
Spores of the aquatic *Isoetes*, *Sphagnum* moss spores, coenobia of the green algae (Chlorophycophyta) *Botryococcus*, and fungal hypodia of *Gaeumannomyces* cf. *caricis* were also found. Indeterminable degraded grains are very common in all RT4 samples and indeterminable broken grains occur in RT4 3-5" (Figure 7).

Figure 8 is a pollen concentration for selected RT4 taxa. *Pinus* pollen concentration ranges from 35-425 grains/gram. *Quercus* has a maximum concentration of 270 grains/gram. Cupressaceae and *Ulmus* have maximum concentrations of approximately 120 grains/gram each. *Ambrosia*-type pollen concentration varies from 145-410 grains/gram. Cyperaceae pollen concentration ranges from 70-220 grains/gram and Chenopodiaceae/Amaranthaceae ranges from 70-160 grains/gram. Indeterminable degraded pollen concentration varies from 355-645 grains/gram with the maximum concentration in RT4 19-21" (Figure 8).

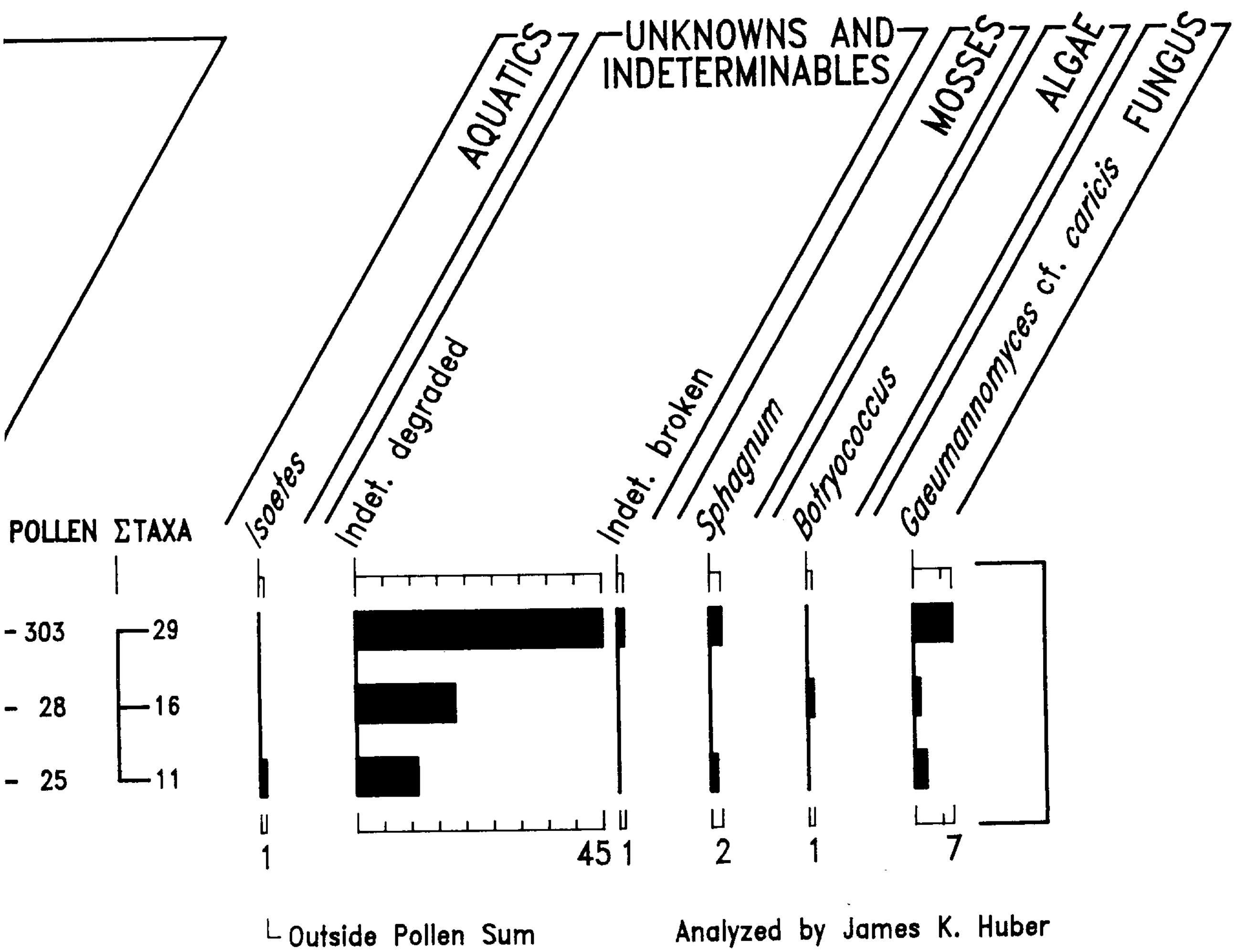
POLLEN AND ALGAE DIAGRAM
ROUBIDOUX TRENCH 4
PULASKI COUNTY, MO
Figure 7



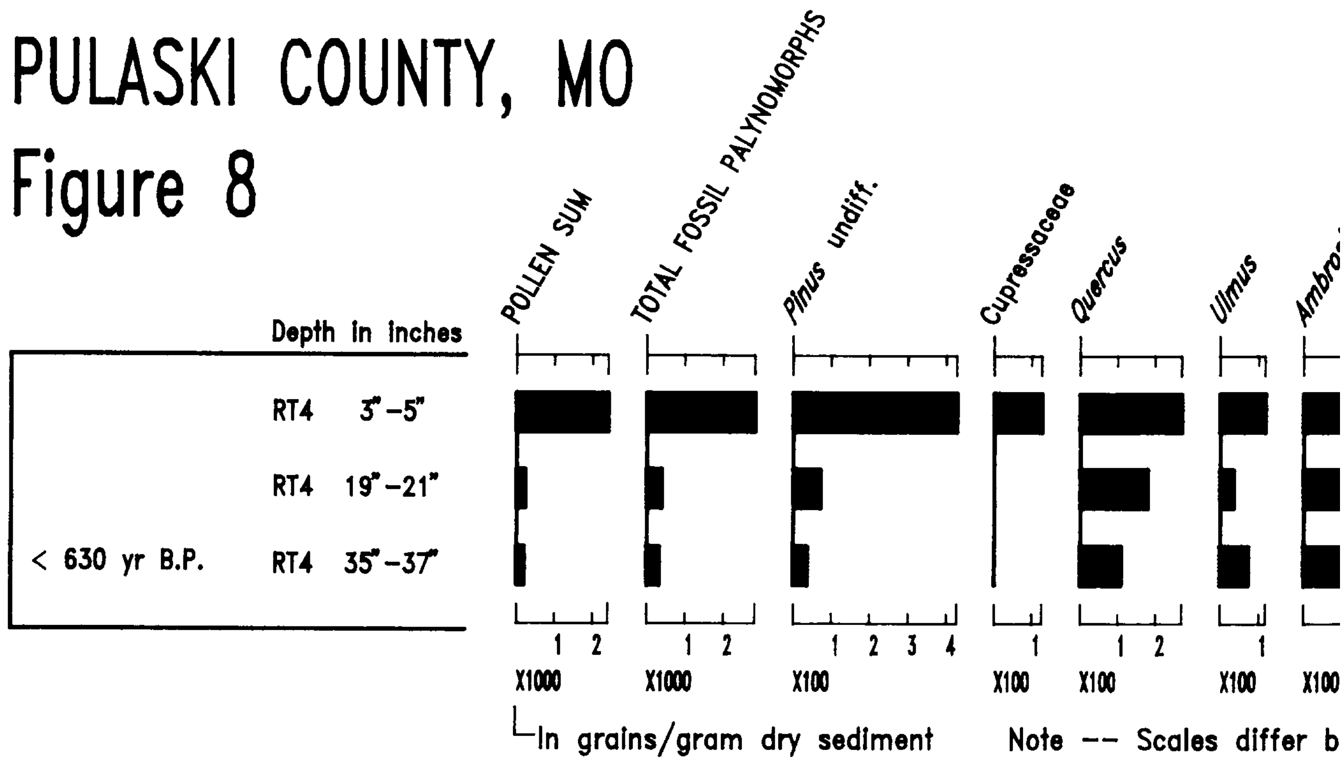
Number of pollen grains.



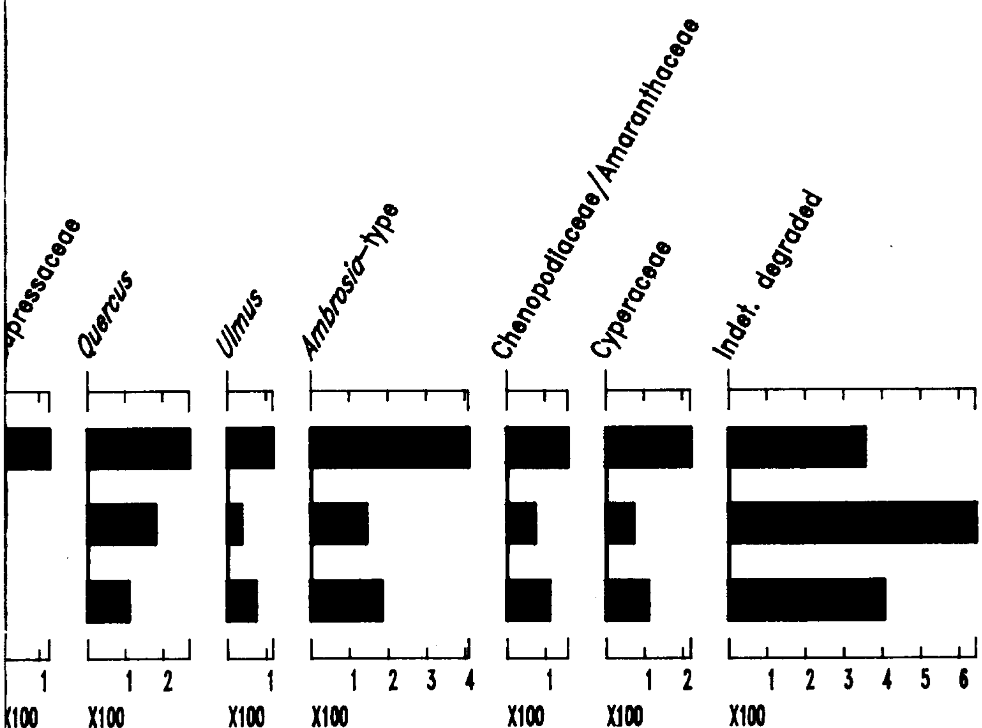
SHRUBS
HERBS
Celtis
Salix
Corylus
Alnus undiff.
Ambrosia-type
Artemisia
Tubuliflorae undiff.
Liguliflorae undiff.
Chenopodiaceae/Amaranthaceae
Sarcobatus vermiculatus
Cyperaceae
Gramineae
Dryopteris-type
Pteridium-type
Lycopodium undiff.
Lycopodium clavatum
Lycopodium complanatum-type
Galium
Umbelliferae
Caryophyllaceae
Cruciferae
Equisetum
Σ POLLEN
Σ TAXA
Isoetes
52
20
28
303
28
25
29
16
11
1
7
1
1
5
2
12
1
5
1
5
6
6
4
5
1
2
1
1
4
4
1
1
Inside Pollen Sum
Outsid


AQUATICS
UNKNOWNS AND INDETERMINABLES
MOSSES
ALGAE
FUNGUS
Isoetes
Indet. degraded
Indet. broken
Sphagnum
Botryococcus
Gaeumannomyces cf. caricis
POLLEN ΣTAXA
303
28
25
29
16
11
1
45
1
2
1
7
Outside Pollen Sum
Analyzed by James K. Huber

POLLEN CONCENTRATION DIAGRAM OF SELECT
ROUBIDOUX TRENCH 4
PULASKI COUNTY, MO
Figure 8



OF SELECTED TAXA



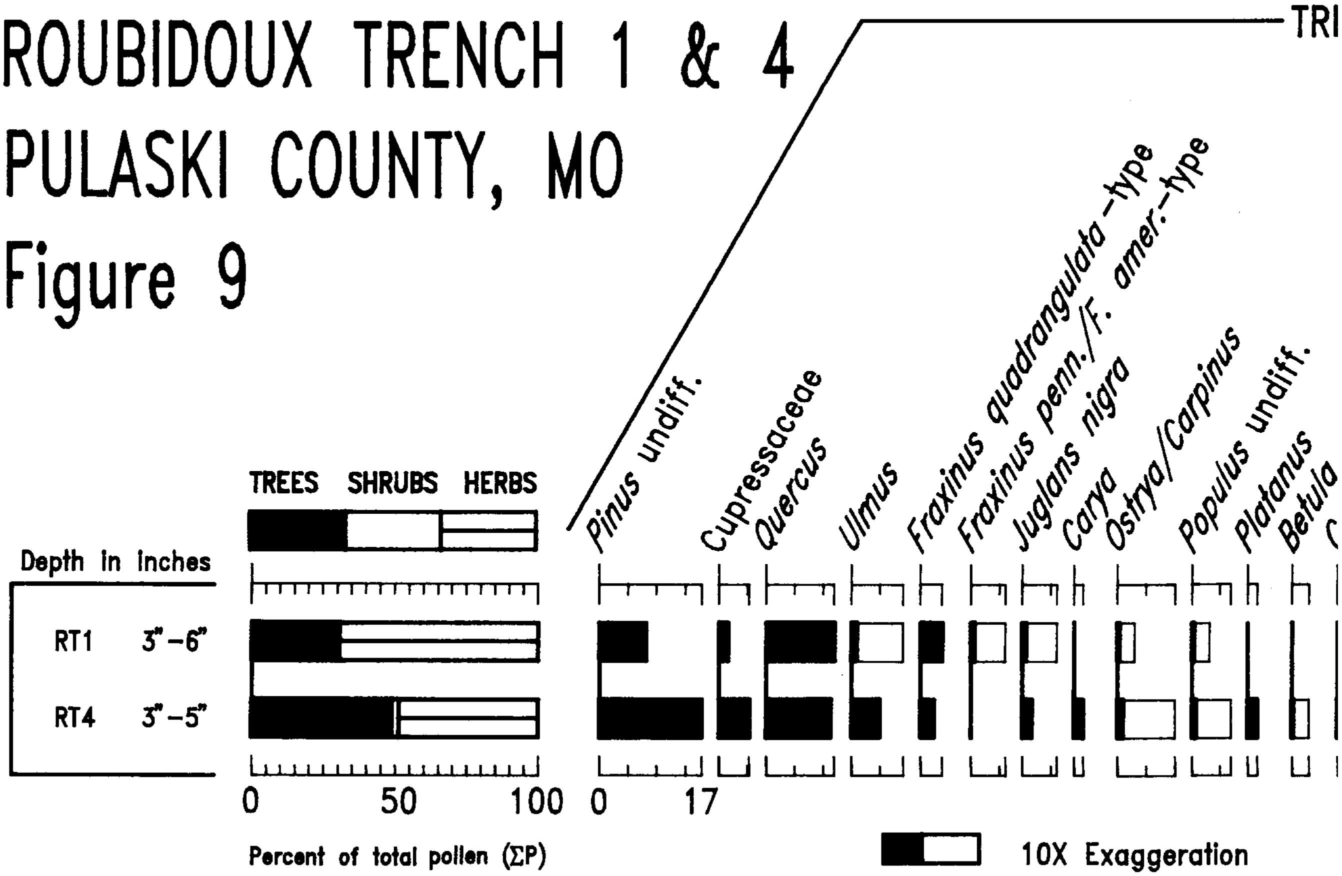
Note -- Scales differ between taxa. Analyzed by James K. Huber

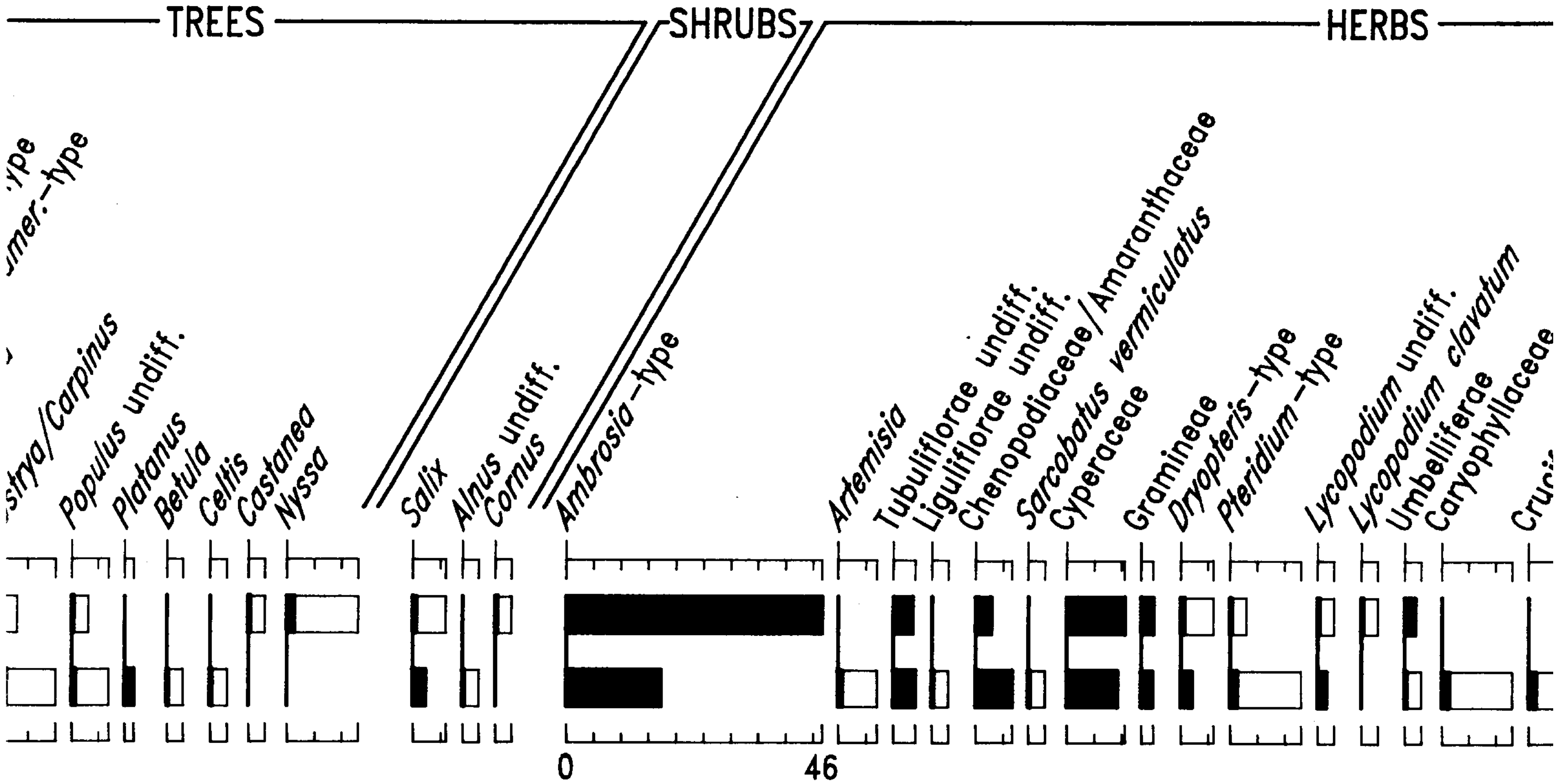
Roubidoux Trench 1 (3-6") and Roubidoux Trench 4 (3-5") Percentage Data:

In these two samples *Pinus*, *Quercus*, Cupressaceae, and *Fraxinus quadrangulata*-type are the dominant AP taxa. *Pinus* is 17% in RT1 and 8% in RT4. *Quercus* is approximately 12% in both samples, while Cupressaceae and *Fraxinus quadrangulata*-type are both 6% or less. *Ambrosia*-type is the dominant NAP type with values of 46% (RT1) and 17% (RT4). Cyperaceae in also prominent at approximately 10% in both samples. Tubuliflorae and Chenopodiaceae/Amaranthaceae are the next most abundant pollen types. Indeterminable degrade has values of RT1 = 7% and RT4 = 13% (Figure 9).

Pollen sum concentration and total fossil palynomorph concentrations are very similar in both samples. At RT1, *Quercus*, *Ambrosia*-type, and Cyperaceae have significantly larger pollen concentrations than at RT4 (Figure 10).

POLLEN PERCENTAGE DIAGRAM
ROUBIDOUX TRENCH 1 & 4
PULASKI COUNTY, MO
Figure 9

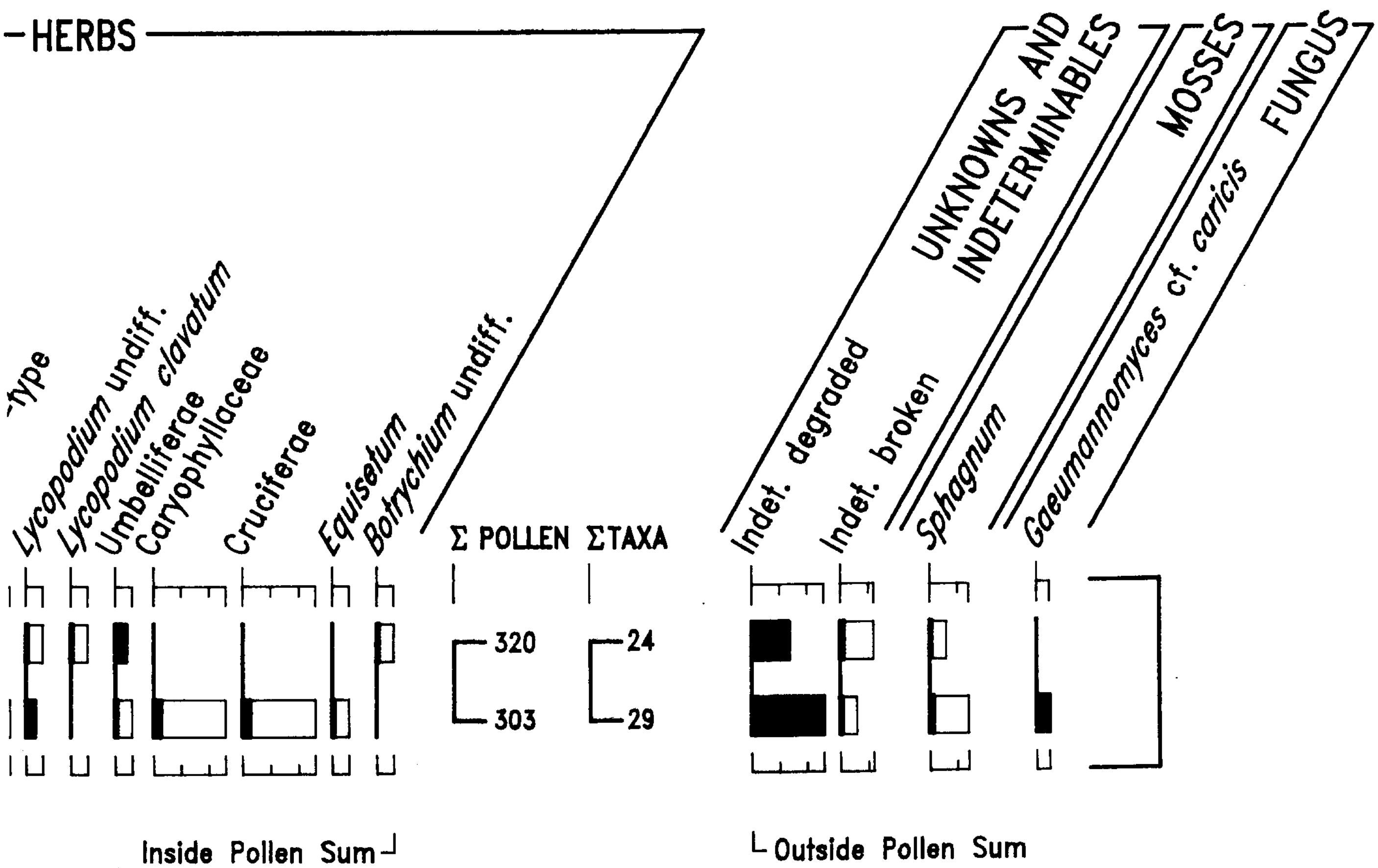




ggeration

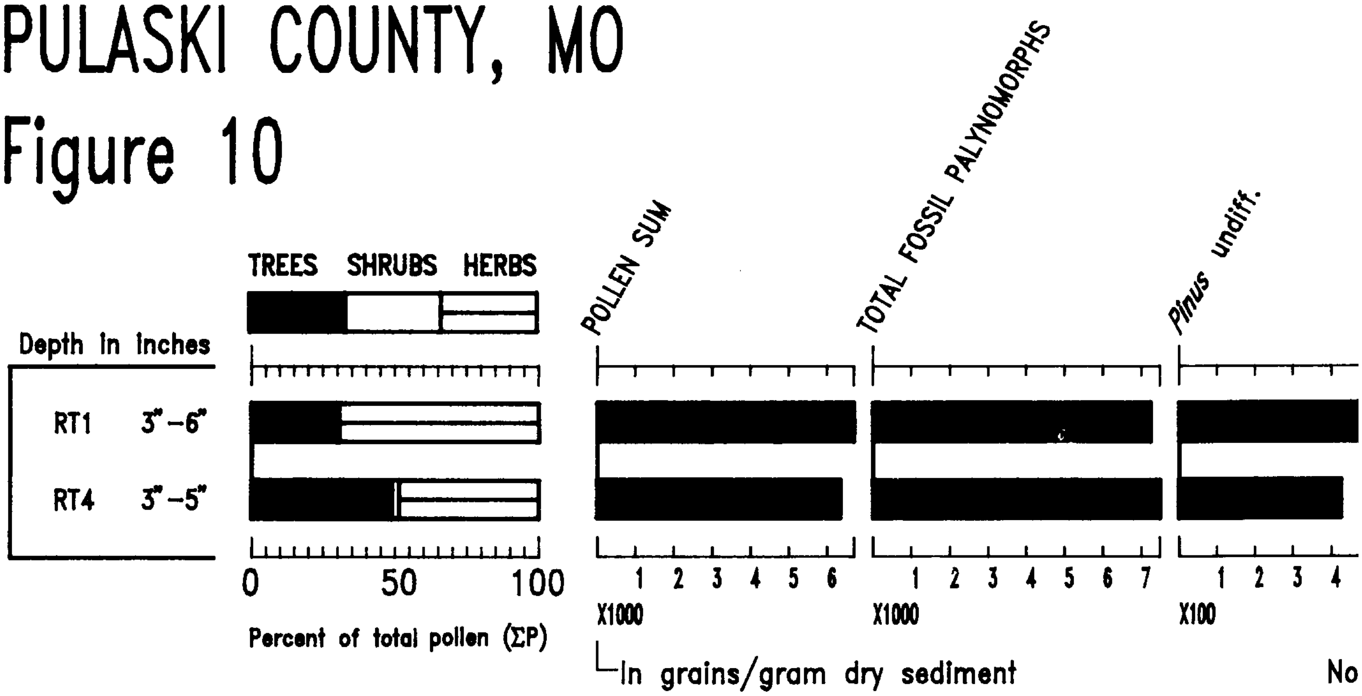
Analyzed by James K. Huber

Inside Pol

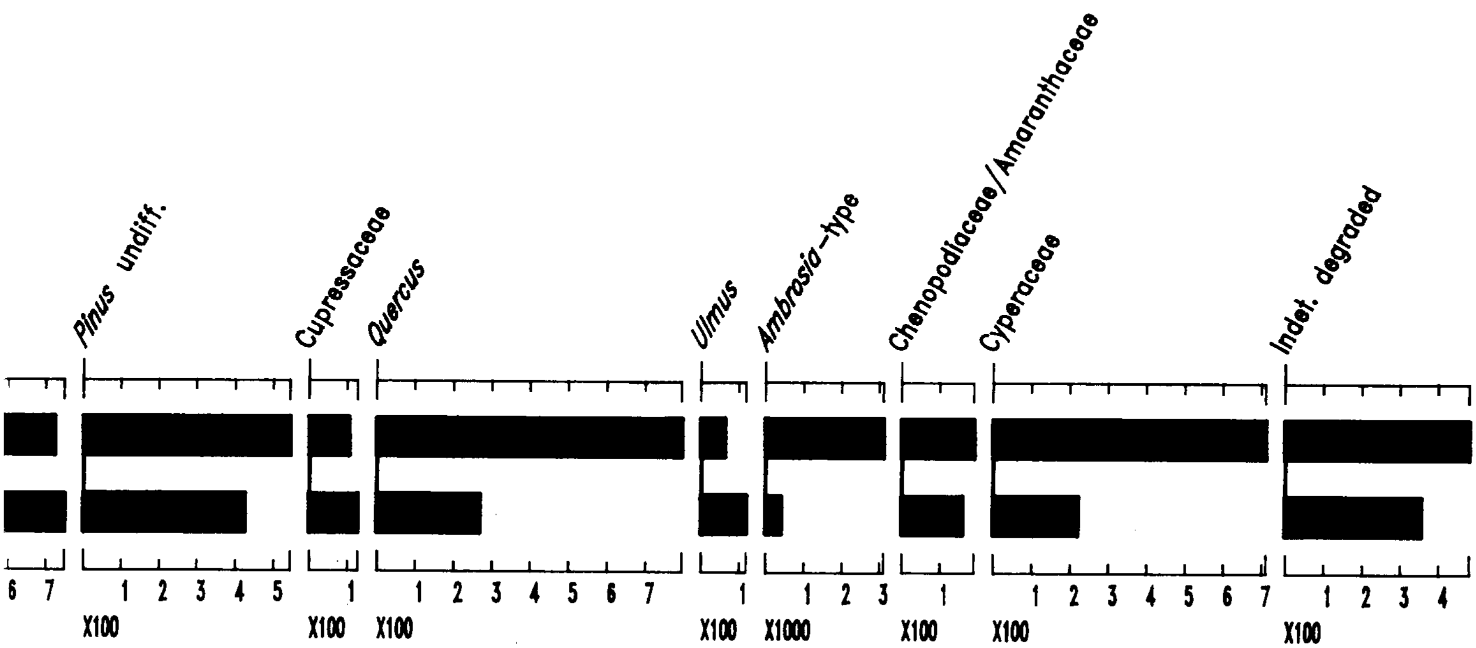


-HERBS
UNKNOWNS AND INDETERMINABLES
MOSSES
FUNGUS
-type
Lycopodium undiff.
Lycopodium clavatum
Umbelliferae
Caryophyllaceae
Cruciferae
Equisetum
Botrychium undiff.
Σ POLLEN
ΣTAXA
Indet. degraded
Indet. broken
Sphagnum
Gaeumannomyces cf. caricis
320
303
24
29
Inside Pollen Sum
Outside Pollen Sum

POLLEN CONCENTRATION DIAGRAM OF SELECTE
ROUBIDOUX TRENCH 1 & 4
PULASKI COUNTY, MO
Figure 10



SELECTED TAXA



Note -- Scales differ between taxa.

Analyzed by James K. Huber

Happy Hollow Borehole 17

HH17 has the poorest pollen preservation of the three sites investigated. No samples contained enough pollen for statistically valid pollen counts. Pollen sum counts varied from 1-21 grains/slide. Within the pollen sum, 23 taxa are represented and the number of taxa/sample ranged from 1 to 10 (Figure 11). Aquatics, mosses, and algae are represented by one taxon in each category. Of the several types observed, only one taxon of fungal spores was identified and counted. Indeterminable pollen consists of only degraded grains. The total number of different taxa identified and counted is 28.

Pollen concentration in HH17 is extremely low. Pollen sum concentration of the HH17 samples varied from 30-620 grains/gram and total fossil palynomorph concentration ranged from 150-1800 grains/gram. The lowest pollen sum and total fossil palynomorph concentration occurred HH17 77-79" and the highest in HH17 48-50" (Figure 12).

In HH17 77-79" only one *Ambrosia*-type pollen grain within the pollen sum was encountered on the entire slide. In the upper seven samples, *Quercus* is the most consistent tree pollen type present. *Pinus*, Cupressaceae, *Ulmus*, *Fraxinus quadrangulata*-type, *Ostrya/Carpinus*, *Betula*, and *Morus* (mulberry) also occur. *Salix* and *Corylus* are the only shrubs present (Figure 11).

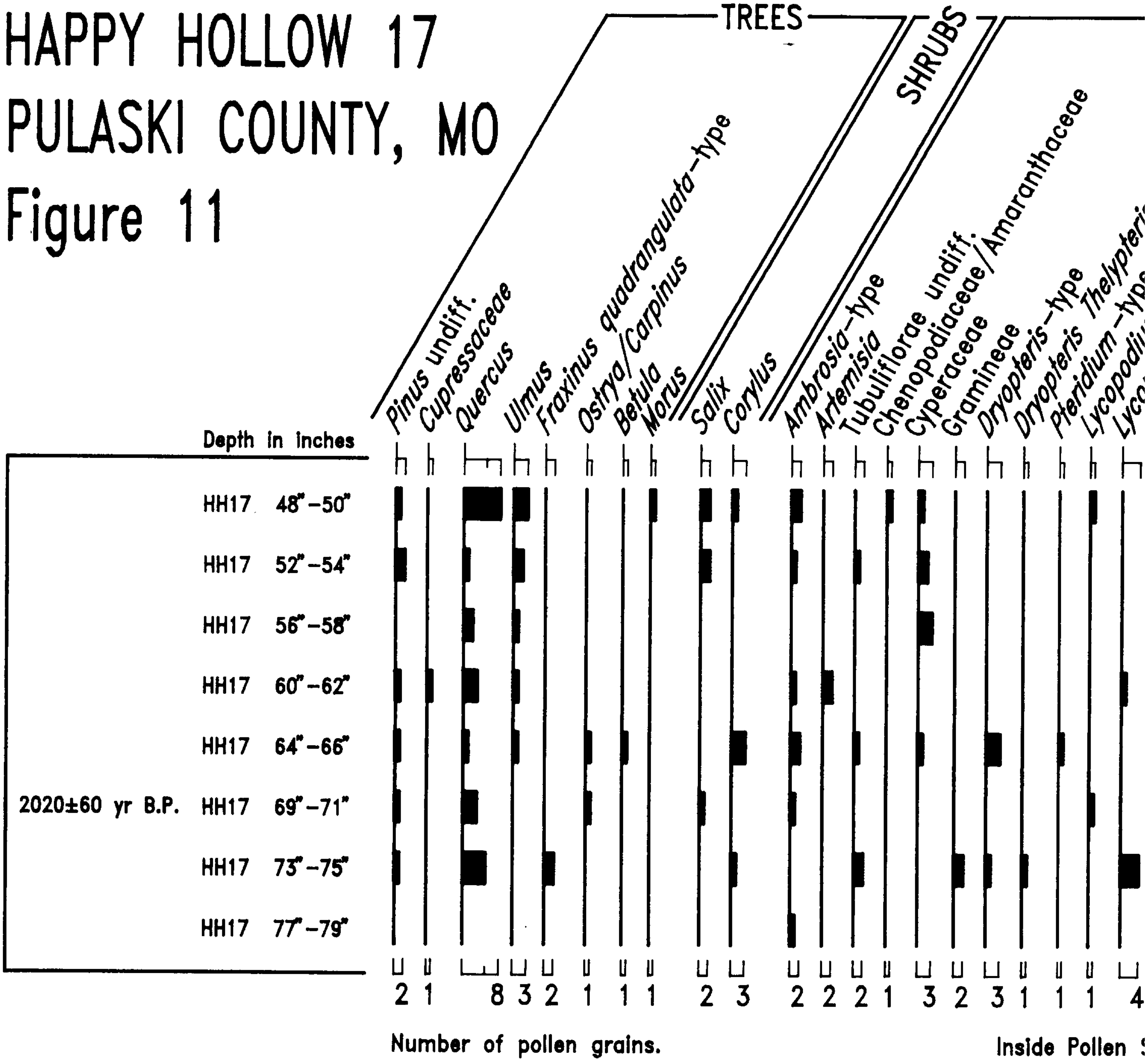
No NAP is present in all HH17 samples. NAP present in the HH17 pollen spectra is *Ambrosia*-type, *Artemisia*, Tubuliflorae, Chenopodiaceae/Amaranthaceae, Cyperaceae, and Gramineae (Figure 11).

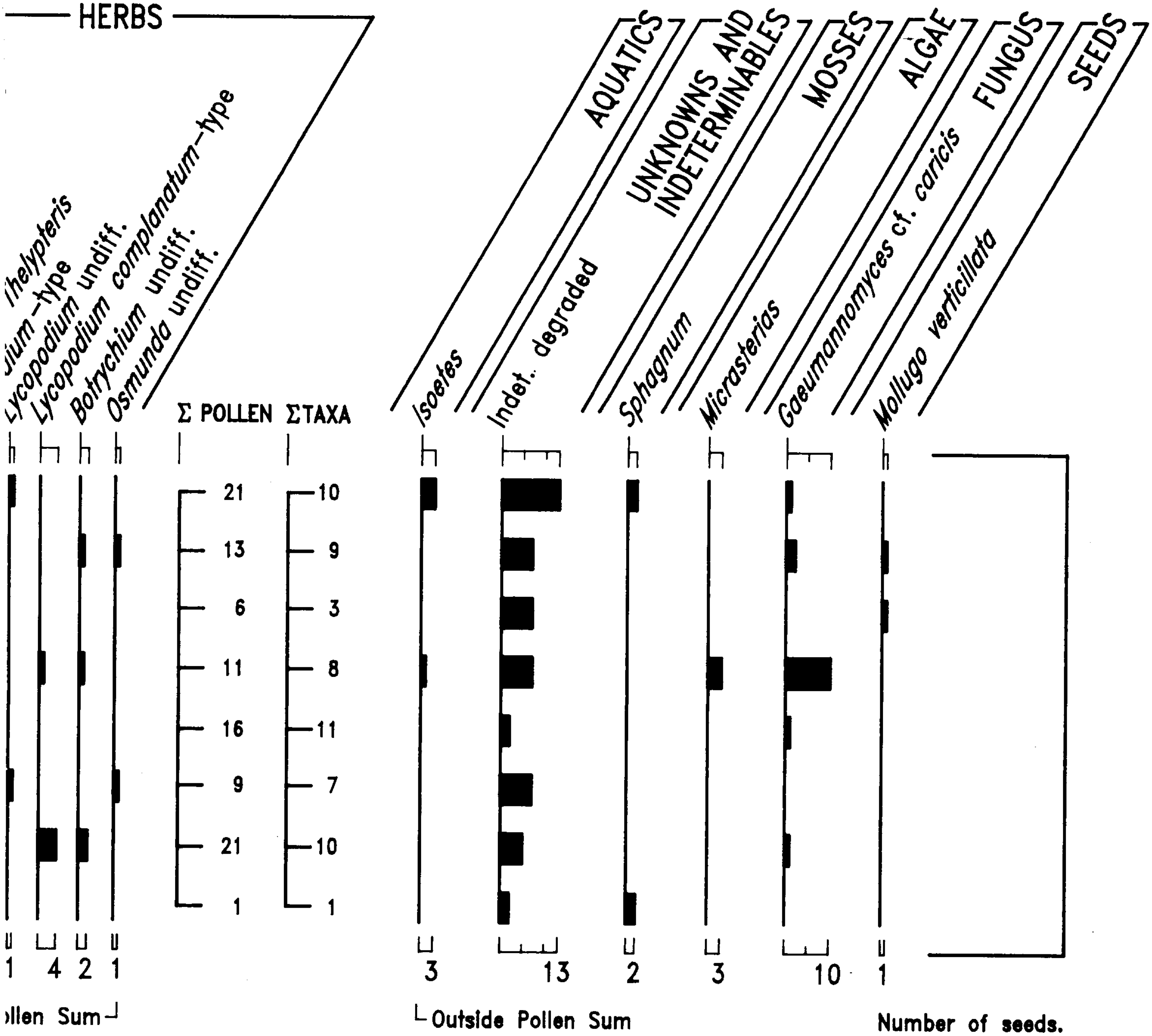
Dryopteris-type, *Dryopteris Thelypteris*, *Pteridium*-type, *Lycopodium*, *Lycopodium complanatum*-type, *Botrychium*, and *Osmunda* are the vascular cryptogams occurring in the HH17 sequence. Spores of the aquatic *Isoetes*, *Sphagnum* moss spores, *Micrasterias* coenobia of the green algae (Chlorophycophyta), and fungal hypodia of *Gaeumannomyces* cf. *caricis* were also found. Indeterminable degraded grains occur in all HH17 samples (Figure 11).

In addition to pollen, seeds of *Mollugo verticillata* (carpet-weed) were recovered from the HH17 52-54" and HH17 56-58" pollen samples (Figure 11).

Quercus pollen concentration ranges from 50-235 grains/gram. *Pinus* has a maximum concentration of 155 grains/gram and a minimum of 20 grains/gram. Cupressaceae only occurs in HH17 60-62" and has a concentration of 27 grains/gram. *Ulmus* concentration values range from 25-155 grains/gram. *Ambrosia*-type pollen concentration varies from 20-100 grains/gram and Cyperaceae concentration ranges from 30-155 grains/gram. Present in only one sample (HH17 48-50"), Chenopodiaceae/Amaranthaceae has a pollen concentration of 30 grains/gram. Indeterminable degraded pollen concentration ranges from 70-545 grains/gram (Figure 12).

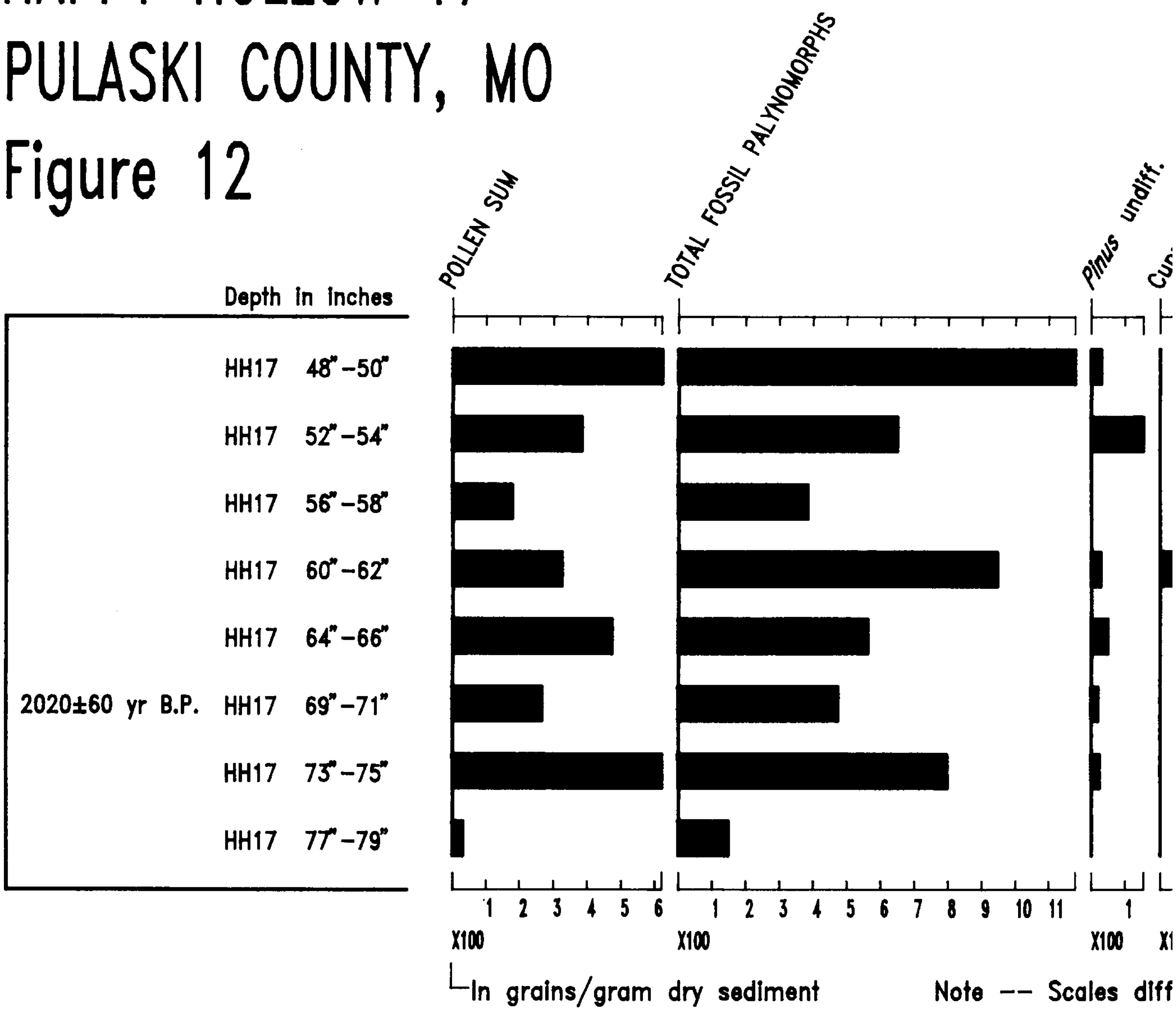
POLLEN, ALGAE, AND SEED DIAGRAM
HAPPY HOLLOW 17
PULASKI COUNTY, MO
Figure 11



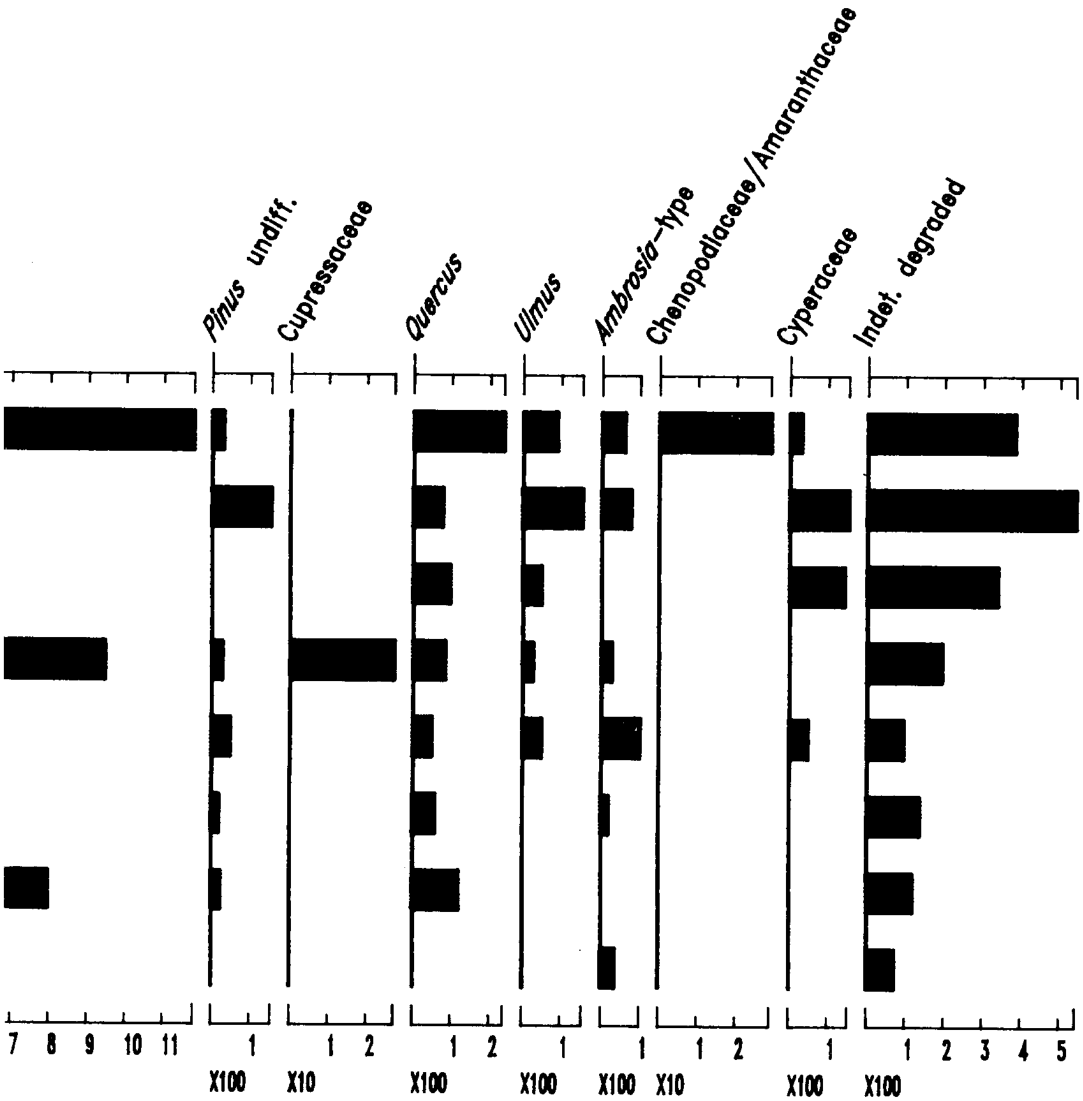


Analyzed by James K. Huber

POLLEN CONCENTRATION DIAGRAM OF SELECT
HAPPY HOLLOW 17
PULASKI COUNTY, MO
Figure 12



OF SELECTED TAXA



Note -- Scales differ between taxa.

Analyzed by James K. Huber

DISCUSSION

Based on the poor pollen preservation and the low pollen concentration in the Fort Leonard Wood samples, the interpretation of the pollen recovered is tenuous. However, some paleoecological inferences can be made especially for samples RT1 (3-6") and RT4 (3-5"). The numerical data from all the sites may be used to indicate the presence of certain taxa in the area.

Pinus pollen is present at all three sites and could only be identified to the genus level because of poor preservation. The pine grains, for the most part, probably represent *Pinus echinata*. According to Steyermark (1963), the northwestern range extent of *Pinus echinata* is Pulaski County.

RT1 has a ^{13}C corrected radiocarbon date of 1370±100 yr B.P. for the 58-61" interval and HH17 ^{13}C corrected radiocarbon date of 2020±60 yr B.P. for at 70" (Paul E. Albertson, personal communication, 1994). By correlation to other sites in the area, the RT4 pollen sequence is less than 630 years old (Paul E. Albertson, personal communication, 1994). These dates give a late Holocene age for pollen spectra from all the Fort Leonard Wood sites.

In most of the previous investigations undertaken in Missouri the pollen sequences reported are older than the Fort Leonard Wood pollen. Although not directly comparable to other pollen assemblages from Missouri because of the poor pollen preservation, the Fort Leonard Wood pollen spectra shows a similar trend to the late Holocene sequences from Buttonbush Bog (Huber, 1987, 1990a) and Cupalo Pond (Smith, 1984). The high *Ambrosia* value in RT1 3"-6" is greater than

that found at other pollen sites in Missouri and probably reflects open and disturbed ground. A somewhat comparable pollen sequence is indicated by the large *Ambrosia* and Tubuliflorae values at Round Spring (Huber, 1987 and Huber and Rapp, 1989). The high *Ambrosia* value is consistent with Peterson's (1978) modern pollen data. The dominant pollen types in the uppermost samples from the three Fort Leonard Wood sites reflect the same trend as the modern pollen data of King (1973), Peterson (1978), and Huber (1990b).

The pollen spectra from Fort Leonard Wood sites indicate that oak, pine, hickory, juniper, elm, ash, hop hornbeam, dogwood, basswood, black walnut, hazel, and mulberry were growing in the uplands and lowland arboreal vegetation consist of pine, hickory, elm, ash, black walnut, hornbeam, cottonwood, tupelo, willow, basswood, sycamore, mulberry, birch, hackberry, hazel, alder. Ragweed, wormwood, goosefoot, amaranth, grasses, bedstraw, and other composites were growing in open and/or disturbed ground areas with sedges in the low moist/wet ground. Shield ferns, bracken ferns, clubmosses, grape ferns, royal ferns, and horsetails were growing in cooler moister areas. Clumps of sphagnum moss could occur both in the upland forest and the lowlands. The streams in the area contained quillwort and the algae *Botryococcus*, *Zygnema*, and *Micrasterias*.

In RT1 locality, the seeds recovered indicate the presence of composites, yellow wood sorrel, bulrush sedges, mints, and nightshade. Based on the seeds found, carpet-weed was growing in disturbed ground in the vicinity of HH17.

The presence of the fungal hypodia of *Gaeumannomyces* cf. *caricis* and the bulrush seeds both indicate that the sedge is of local origin. Van Geel (1986) reports a correlation between the presence this fungi and the local appearance of Cyperaceae in peat, indicating that the Cyperaceae pollen is probably from a local source.

The pollen spectra from the three Fort Leonard Wood sites are indicative of the Oak-Hickory-Pine forests found today in the south-central Missouri Ozarks. Variation in the local Ozark vegetation in the vicinity of the three sites investigated is also reflected.

References Cited

Beilman, A.P. and Brenner, L.G., 1951a, The recent intrusion of forests in the Ozarks: Annals of the Missouri Botanical Gardens, v. 38, p. 261-282.

Beilman, A.P., and Brenner, L.G. 1951b, Changing forest flora in the Ozarks: Annals of the Missouri Botanical Gardens, v. 38, p 283-291.

Bernabo, J.C., and Webb, T., III, 1977, Changing Patterns in the Holocene pollen record of northeastern North America: A mapped summary: Quaternary Research, v. 8, p. 64-96.

Braun, E.L., 1950, Deciduous forests of eastern North American: Philadelphia, The Blakiston Company, 596 p.

Brush, G.S., 1967, Pollen analysis of late-glacial and post-glacial sediments in Iowa, *in* Cushing, E.J., and Wright, H.E., Jr., eds., Quaternaty Paleoecology: New Haven, Yale University Press, p. 99-115.

Cushing, E.J., 1967, Evidence for differntial pollen preservation in late Quaternary sediments in Minnesota: Review of Paleobotany and Palynology, v. 4, p. 87-101.

Cronberg, G., 1986, Blue-green algae, green algae and Chrysophyceae in sediments, *in* Berglund, B.E., ed., Handbook of Holocene palaeoecology and palaeohydrology: Chichester, John Wiley & Sons, LTD, p. 507-526.

Cwynar, L.C., Burden, E., and McAndrews, J.H., 1979, An inexpensive sieving method for concentrating pollen and spores from fine-grained sediments: Canadian Journal of Earth Science, v. 16, p. 1116-1120.

Dean, W.E., Jr., 1974, Determination of carbonate and organic matter in calcareous sediments and sedimentary rocks by loss on ignition: Comparison with other methods: Journal of Sedimentary Petrology, v. 44, no. 1, p. 242-248.

Dice, L.R., 1943, The biotic provinces of North America: Ann Arbor, University of Michigan Press, 77 p.

Durkee, L.H., 1971, A pollen profile from Woden Bog in north central Iowa: Ecology, v. 52, p. 837-844.

Faegri, K., and Iverson, J., 1975, Textbook of pollen analysis (third edition): New York. Hafner Press, 295 p.

Gruger, E., 1972, Late Quaternary vegetation development in south central Illinois: Quaternary Research, v. 2, p. 217-231.

Hanson, H.C., 1962, Dictionary of ecology: Washington, D.C., Philosophical Library, Incorporated, 382 p.

Huber, J.K., 1980, Plant macrofossil, molluscan, and pollen analysis of Holtz Bog, Muscatine County, Iowa [Senior thesis]: Iowa City, University of Iowa, 46 p.

Huber, J.K., 1985, Pollen concentration diagram, Lake Superior core, V83-1G, *in* Sholz, C.A., Sediment distribution and sedimentation rates in the western arm of Lake Superior using 3.5kH2 seismic reflection profiles and ^{210}Pb geochronology [M.S. thesis]: Duluth, University of Minnesota-Duluth, p. 86.

Huber, J.K., 1987, A late Holocene vegetational sequence from the southeast Missouri Ozarks [M.S. thesis]: Duluth, University of Minnesota, Duluth, 206 p.

Huber, J.K., 1990a, A late Holocene pollen record from the southeast Missouri Ozarks [abs.]: CANQUA/AMQUA 1990, Programme and Abstracts, Waterloo, Ontario, p. 20.

Huber, J.K., 1990b, Modern pollen rain in the southeast Missouri Ozarks: American Midland Naturalist, v. 124, no. 2, p. 263-268.

Huber, J.K., and Rapp, G., Jr., 1981, rev. 1983, The identification of critical plants which could be used for phytolith and pollen studies to determine late Pleistocene and Holocene climatic change in the Missouri Ozark uplands: Report submitted to the National Park Service, Midwest Archaeological Center, Lincoln, Nebraska, 182 p.

Huber, J.K., and Rapp, G., Jr., 1989, The palynology of two archaeological sites in the southeast Missouri Ozarks: Plains Anthropologist, v. 34, no. 126, p. 293-308.

Kapp, R.O., 1969, How to know pollen and spores: Dubuque, IA, W.C. Brown Company, 249 p.

King, J.E., 1973, Late Pleistocene palynology and biogeography of the western Missouri Ozarks: Ecological Monographs, v. 43, no. 4, p. 539-565.

King, J.E., 1981, Late Quaternary vegetational history of Illinois: Ecological Monographs, v. 51, no. 1, p. 43-62.

King, J.E., 1985, Palynological applications to archaeology: An overview, *in* Rapp, G., Jr., and Gifford, J.A., eds., Archaeological geology: New Haven, Yale University Press, p. 135-154.

King, J.E., and Allen, W.H., Jr., 1977, A Holocene vegetation record from the Mississippi River valley, southeastern Missouri: Quaternary Research, v. 8, p. 307-323.

King, J.E., and Lindsay, E.H., 1976, Late Quaternary biotic records from spring deposits in western Missouri, *in* Wood, W.R., and McMillan, R.B., eds., Prehistoric man and his environments: A case study in the Ozark Highland: New York, Academic Press, p. 63-78.

Küchler, A.W., 1964, Potential natural vegetation of the conterminous United States: American Geographical Society Special Publication 36, 156 p., Map scale 1:3,168,000.

Maher, L.J., Jr., 1972, Absolute pollen diagram of Redrock Lake, Boulder County, Colorado: Quaternary Research, v. 2, p. 531-553.

McMillan, R.B., and King, J.E., 1974, Evidence for Holocene biogeographic change in Missouri's western Ozarks [abs.]: American Quaternary Association Abstracts, Third meeting, Madision, Wisconsin, p. 119.

Mehringer, P.J., Jr., King, J.E., and Lindsay, E.H., 1970, A record of Wisconsin-age vegetation and fauna from the Ozarks western Missouri, *in* Dort, W., Jr., and Jones, J.K., Jr., eds., Pleistocene and recent environments of the central Great Plains: Lawrence, The University Press of Kansas, p. 173-183.

Mehringer, P.J., Jr., Schweger, C.E., Wood, W.R., and McMillan, R.B., 1968, Late-Pleistocene boreal forest in the western Ozark Highlands?: Ecology, v. 49, no. 3, p. 567-568.

Mendel, J.J., 1961, Timber resources of the eastern Ozarks: U.S. Department of Agriculture Forest Service, University of Missouri Agricultural Experiment Station B779, 74 p.

Moore, P.D., and Webb, J.A., 1978, An illustrated guide to pollen analysis: London, Hodder and Stoughton, 133 p.

Peterson, G.M., 1978, Pollen specta from surface sediments of lakes and ponds in Kentucky, Illinois, and Missouri: The American Midland Naturalists, v. 100, no. 2, p. 330-340.

Royall, P.D., 1988, Late-Quaternary paleoecology and paleoenvironments of the Western Lowlands, southeast Missouri [M.S. thesis]: Knoxville, University of Tennessee, 181 p.

Royall, P.D., Delcourt, P.A., and Delcourt, H.R., 1991, Late Quaternary and paleoenvironments of the Central Mississippi Alluvial Valley: Geological Society of America Bulletin, p. 157-170.

Sauer, C.O., 1920, The geography of the Ozark Highland of Missouri: Chicago, University of Chicago Press, 245 p.

Smith, E.N., Jr., 1984, Late-Quaternary vegetational history at Cupalo Pond, Ozark National Senic Riverways, southeast Missouri [M.S. thesis]: Knoxville, University of Tennessee, 115 p.

Steyermark, J.A., 1940, Studies of the vegetation of Missouri, I, natural associations and succession in the Ozarks of Missouri: Field Museum of Natural History Botanical Series, v. 9, p. 349-375.

Steyermark, J.A., 1959, Vegetational history of the Ozark forest: The University of Missouri Studies No. 31, 138 p.

Steyermark, J.A., 1963, Flora of Missouri (sixth printing): Ames, Iowa State University Press, 1728 p.

Van Zant, K.L., 1976, Late- and postglacial vegetational history of northern Iowa [Ph.D. thesis]: Iowa City, University of Iowa, 123 p.

Van Zant, K.L., 1979, Late glacial and postglacial pollen and plant macrofossils from Lake West Okoboji, northeastern Iowa: Quaternary Research, v. 12, p. 358-380.

Van Geel, B., 1986, Application of fungal and algae remains and other microfossils in palynological analyses, *in* Berglund, B.E., ed., Handbook of Holocene palaeoecology and palaeohydrology: Chichester, John Wiley & Sons, LTD, p. 497-505.

Watts, W.A., and Bright, R.C., 1968, pollen, seed, and mollusk analysis of a sediment core from Pickerel Lake, northeastern South Dakota: Geological Society of America Bulletin, v. 79, p. 855-876.

Watts, W.A., and Winter, T.C., 1966, Plant macrofossils from Kirchner Marsh, Minnesota--a paleoecological study: Geological Society of America Bulletin, v. 77, p. 1339-1360.

Webb, T., III, and Bryson, R.A., 1972, Late- and postglacial climatic change in the northern midwest, USA: Quantitative estimates derived from fossil pollen spectra by multivariate statistical analysis: Quaternary Research, v. 2, p. 70-115.

Williams, N.E., 1981, Aquatic organisms and palaeoecology: recent and future trends, *in* Lock, M.A., and Williams, D.D., eds., Perspectives in running water ecology: New York, Plenum Press, p. 289-303.

Winter, T.C., 1962, Pollen sequence at Kirchner Marsh, Minnesota: Science, v. 138, p. 526-528.

Wright, H.E., Jr., 1968, History of the Prairie Peninsula, *in* Bergstrom, R.E., ed., The Quaternary of Illinois: Urbana, University of Illinois College of Agriculture Special Report 14, p. 78-88.

Wright, H.E., Jr., 1971, Late Quaternary vegetational history of North America, *in* Turekian, K.K., ed., Late Cenozoic glacial ages: New Haven, Yale University Press, p. 425-464.

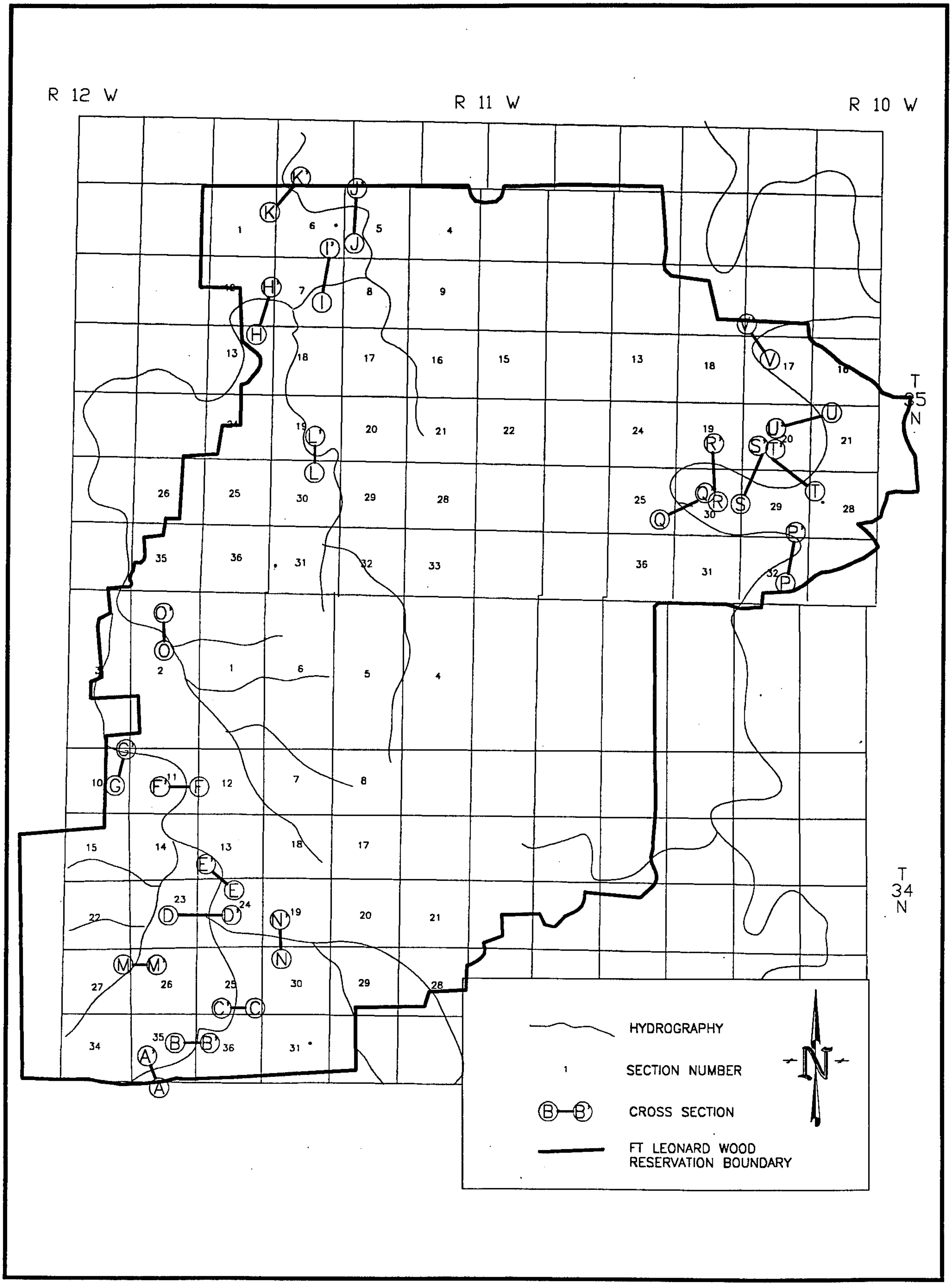

R 12 W
R 11 W
R 10 W
T 35 N
T 34 N
HYDROGRAPHY
SECTION NUMBER
CROSS SECTION
FT LEONARD WOOD RESERVATION BOUNDARY
N

Plate 1

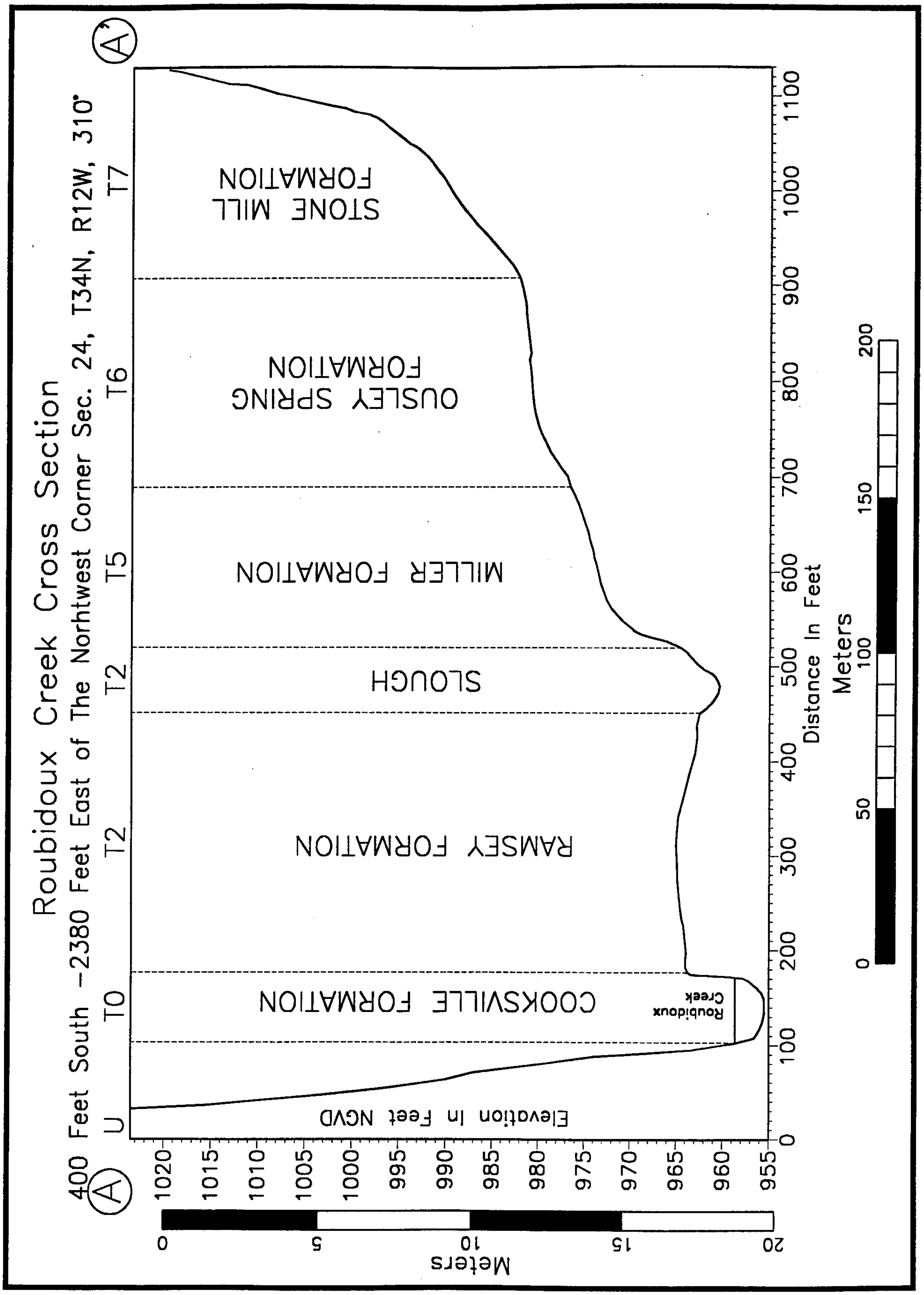

Roubidoux Creek Cross Section
400 Feet South -2380 Feet East of The Northwest Corner Sec. 24, T34N, R12W, 310°
A
A'
U
T0
T2
T2
T5
T6
T7
COOKSVILLE FORMATION
Roubidoux Creek
RAMSEY FORMATION
SLOUGH
MILLER FORMATION
OUSLEY SPRING FORMATION
STONE MILL FORMATION
Elevation In Feet NGVD
Distance In Feet
Meters
Meters

Plate 2

Roubidoux Creek Cross Section

2250 Feet South -900 Feet West of The Norhtwest Corner Sec. 35, T34N, R12W, 90°

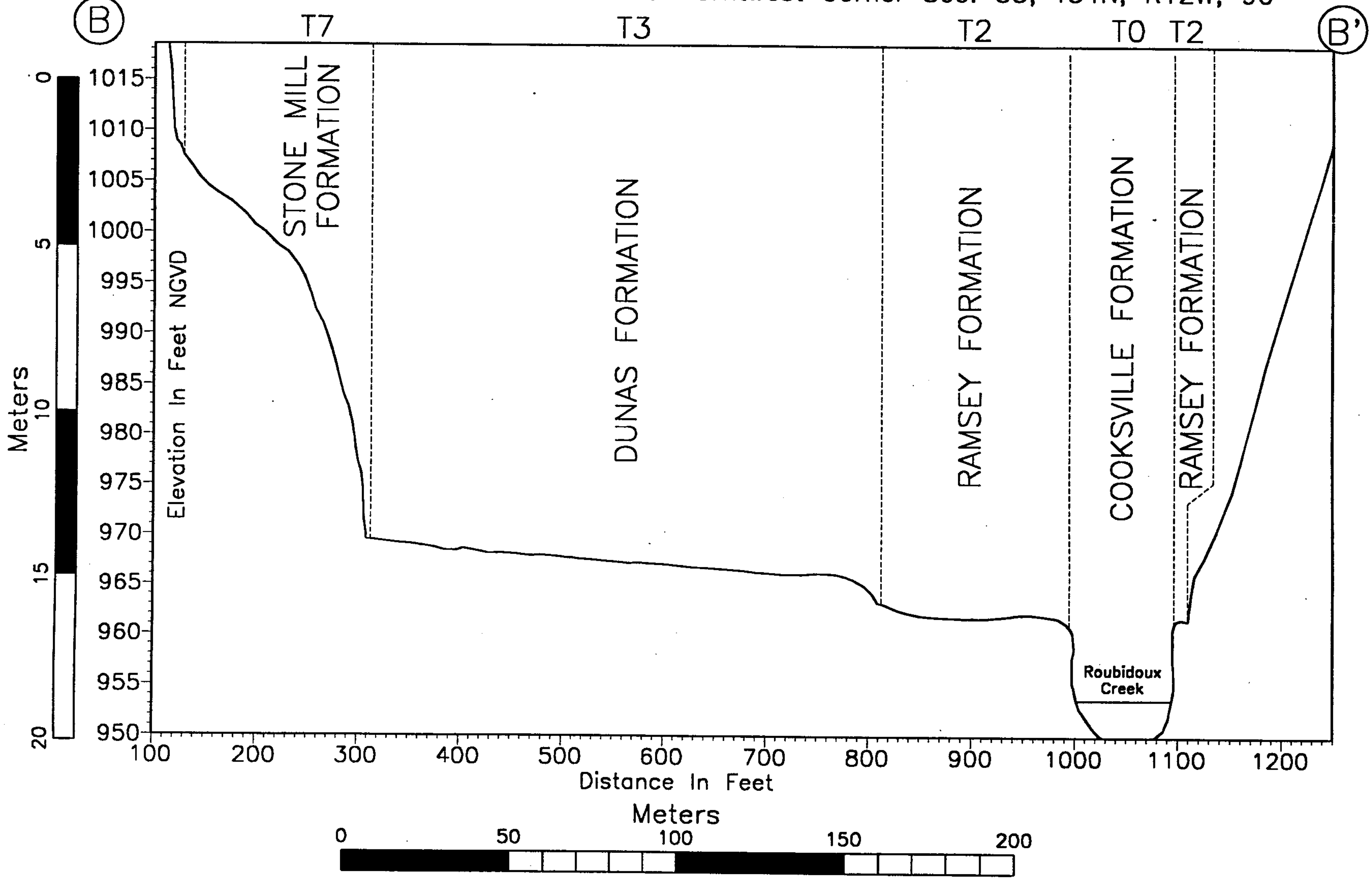
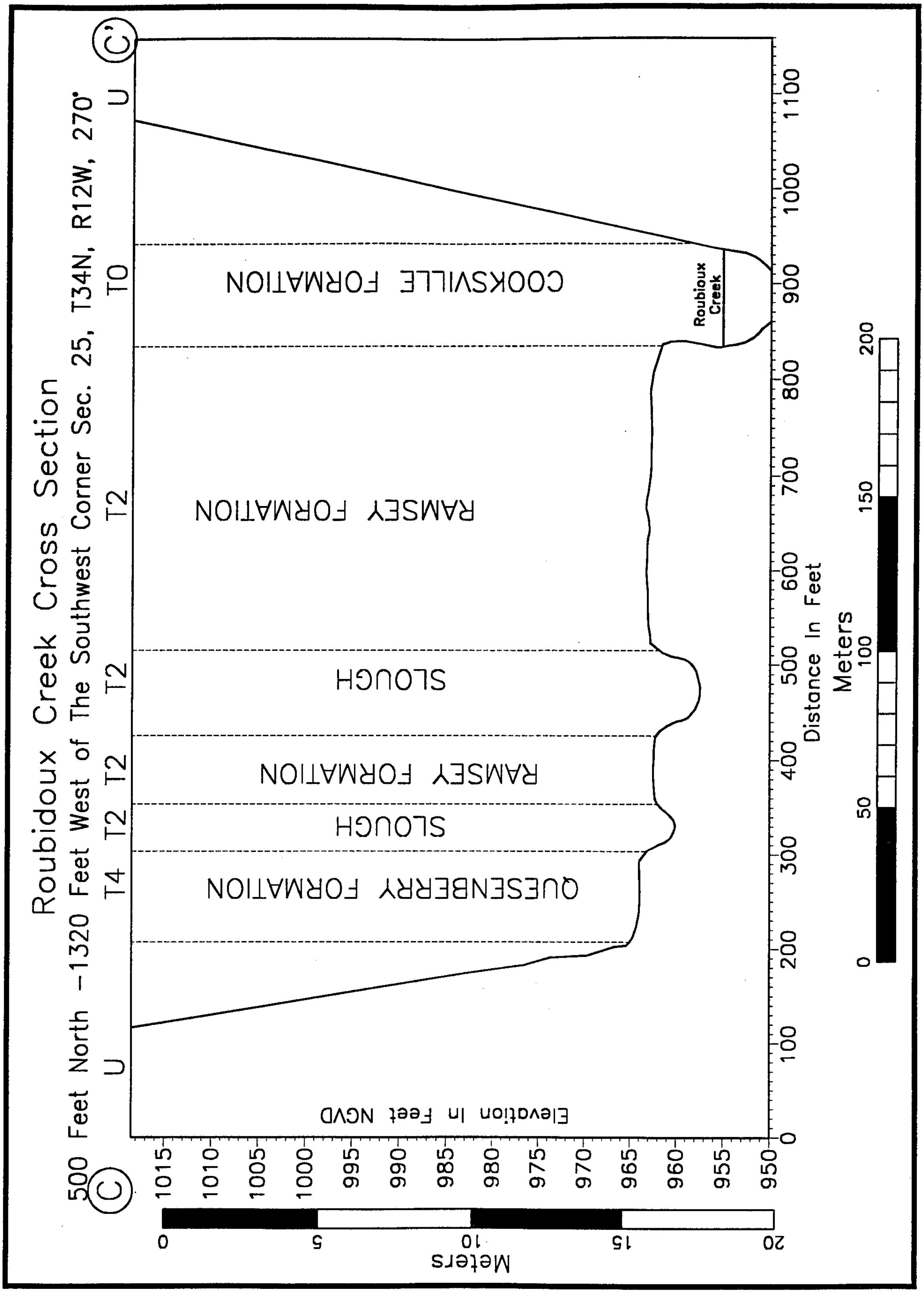


Plate 3

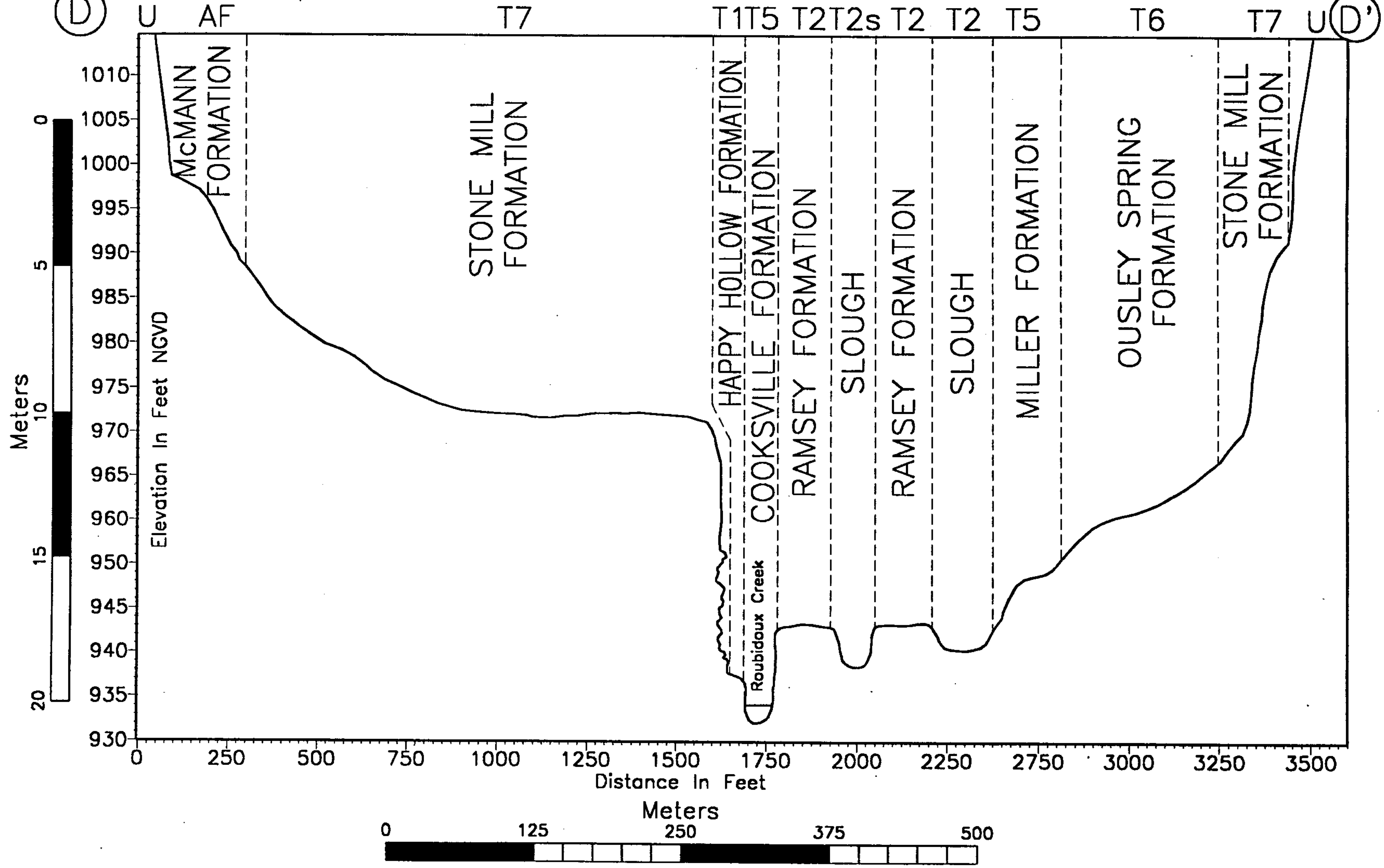


Roubidoux Creek Cross Section
500 Feet North -1320 Feet West of The Southwest Corner Sec. 25, T34N, R12W, 270°
C
C'
U
T4
T2
T2
T2
T2
T0
U
QUESENBERRY FORMATION
SLOUGH
RAMSEY FORMATION
SLOUGH
RAMSEY FORMATION
COOKSVILLE FORMATION
Roubidoux Creek
Elevation In Feet NGVD
1015
1010
1005
1000
995
990
985
980
975
970
965
960
955
950
0
100
200
300
400
500
600
700
800
900
1000
1100
Distance In Feet
Meters
0
50
100
150
200
Meters
0
5
10
15
20

Plate 4

Roubidoux Creek Cross Section

2590 Feet North -1500 Feet West of The SouthEast Corner Sec. 23, T34N, R12W, 90°



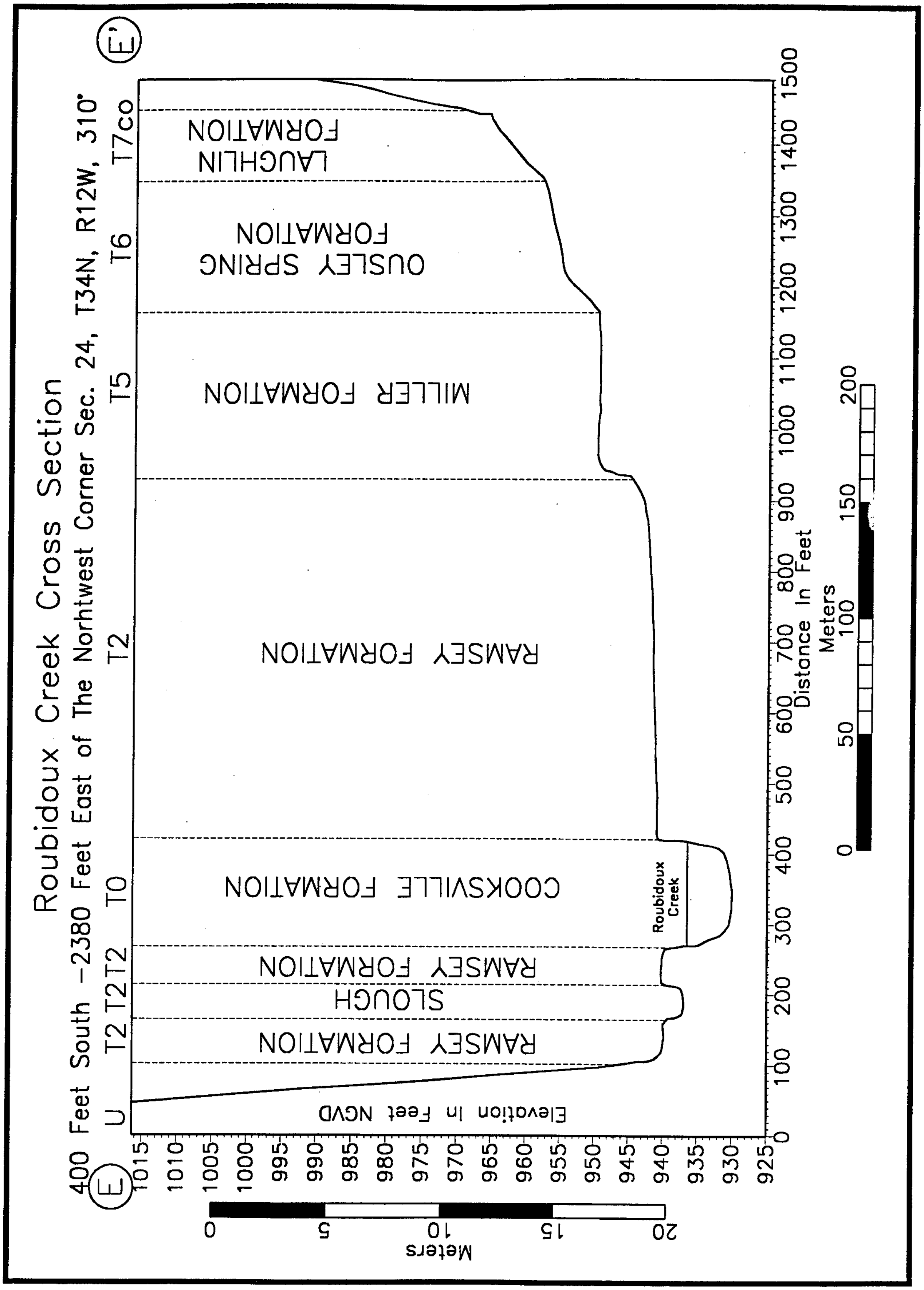

Roubidoux Creek Cross Section
400 Feet South -2380 Feet East of The Norhtwest Corner Sec. 24, T34N, R12W, 310°
E
E'
U
T2
T2
T2
T0
T2
T5
T6
T7co
RAMSEY FORMATION
SLOUGH
RAMSEY FORMATION
COOKSVILLE FORMATION
Roubidoux Creek
RAMSEY FORMATION
MILLER FORMATION
OUSLEY SPRING FORMATION
LAUGHLIN FORMATION
Elevation In Feet NGVD
Distance In Feet
Meters
Meters

Plate 6

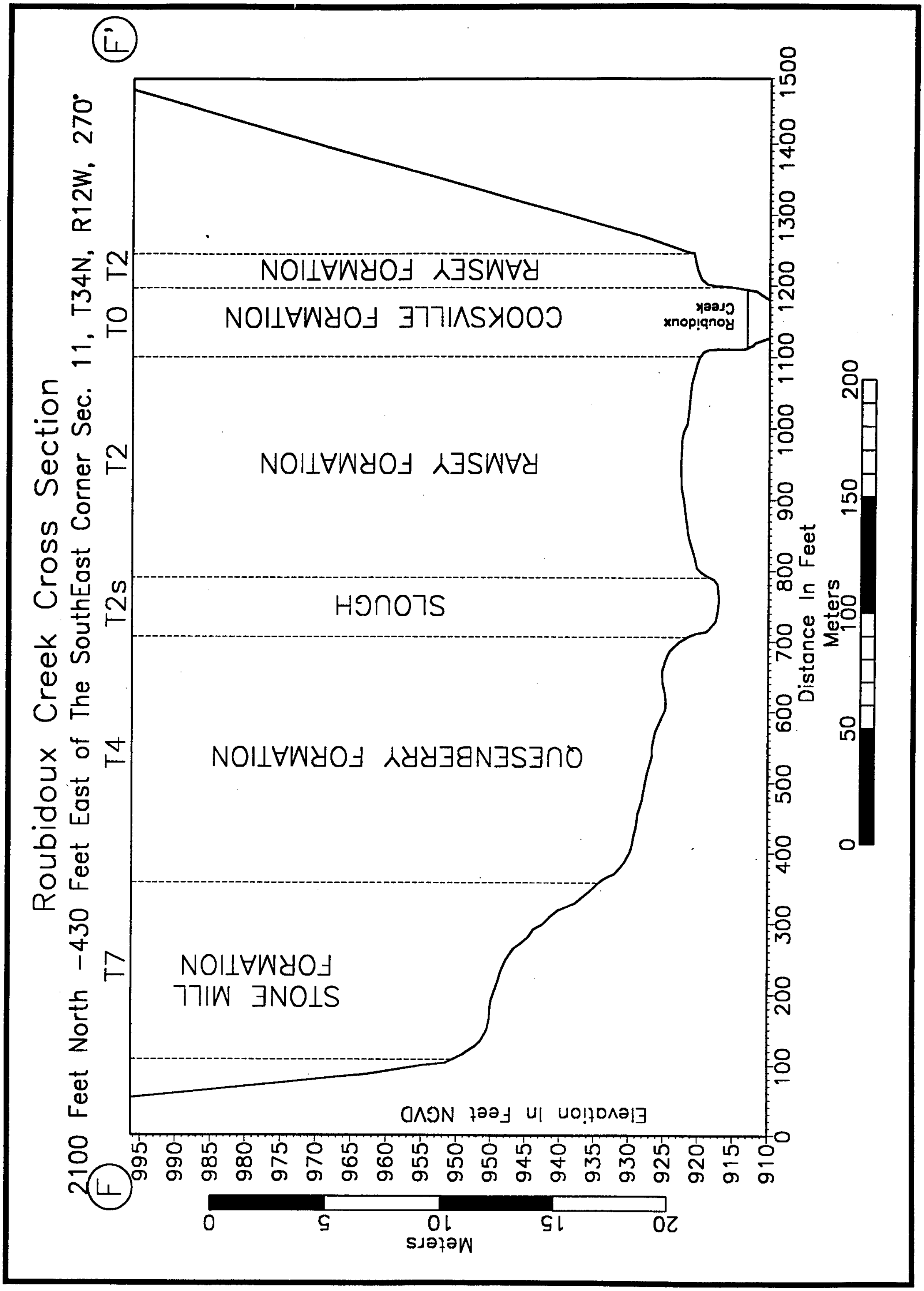
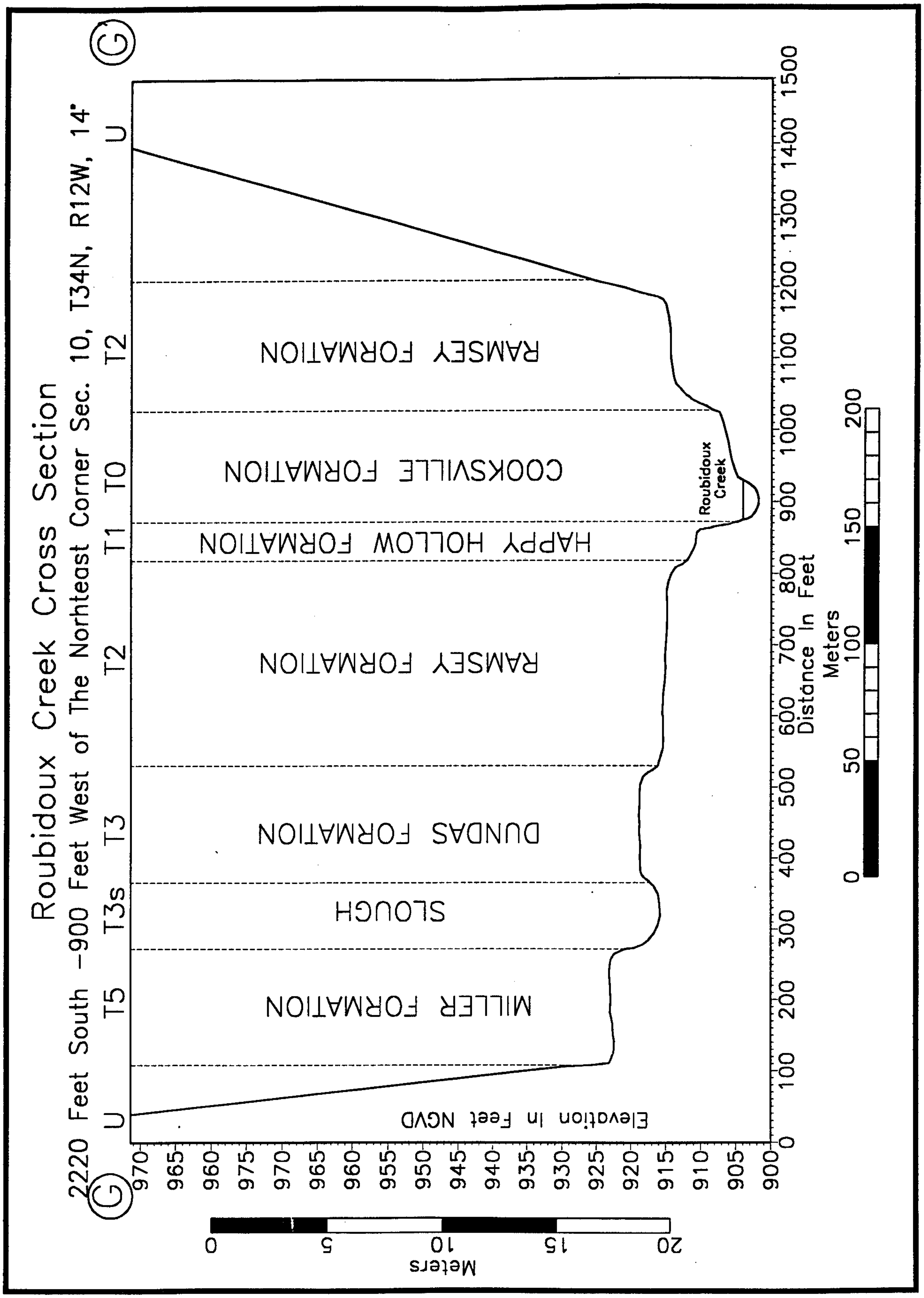

Roubidoux Creek Cross Section
2100 Feet North -430 Feet East of The SouthEast Corner Sec. 11, T34N, R12W, 270°
F
F'
T7
T4
T2s
T2
T0
T2
STONE MILL FORMATION
QUESENBERRY FORMATION
SLOUGH
RAMSEY FORMATION
COOKSVILLE FORMATION
RAMSEY FORMATION
Roubidoux Creek
Elevation In Feet NGVD
Distance In Feet
Meters
Meters

Plate 7

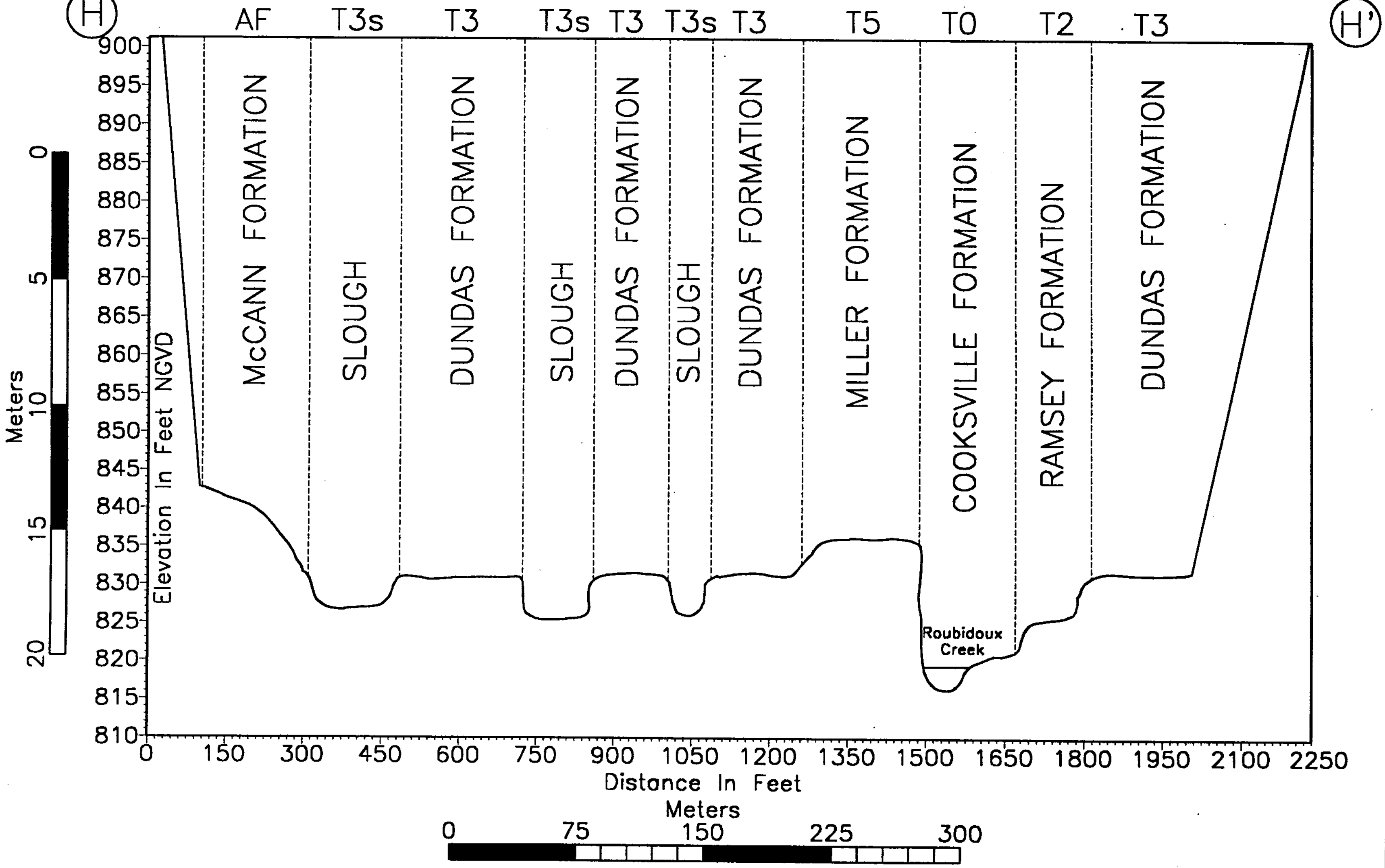


Roubidoux Creek Cross Section
2220 Feet South -900 Feet West of The Norhteast Corner Sec. 10, T34N, R12W, 14°
G
G'
U
T5
T3s
T3
T2
T1
T0
T2
U
MILLER FORMATION
SLOUGH
DUNDAS FORMATION
RAMSEY FORMATION
HAPPY HOLLOW FORMATION
COOKSVILLE FORMATION
RAMSEY FORMATION
Roubidoux Creek
Elevation In Feet NGVD
Distance In Feet
Meters
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500
970 965 960 975 970 965 960 955 950 945 940 935 930 925 920 915 910 905 900
0 50 100 150 200
0 5 10 15 20

Plate 8

Roubidoux Creek Cross Section

220 Feet North –1060 Feet West of The Southeast Corner Sec. 12, T35N., R12W, 18'



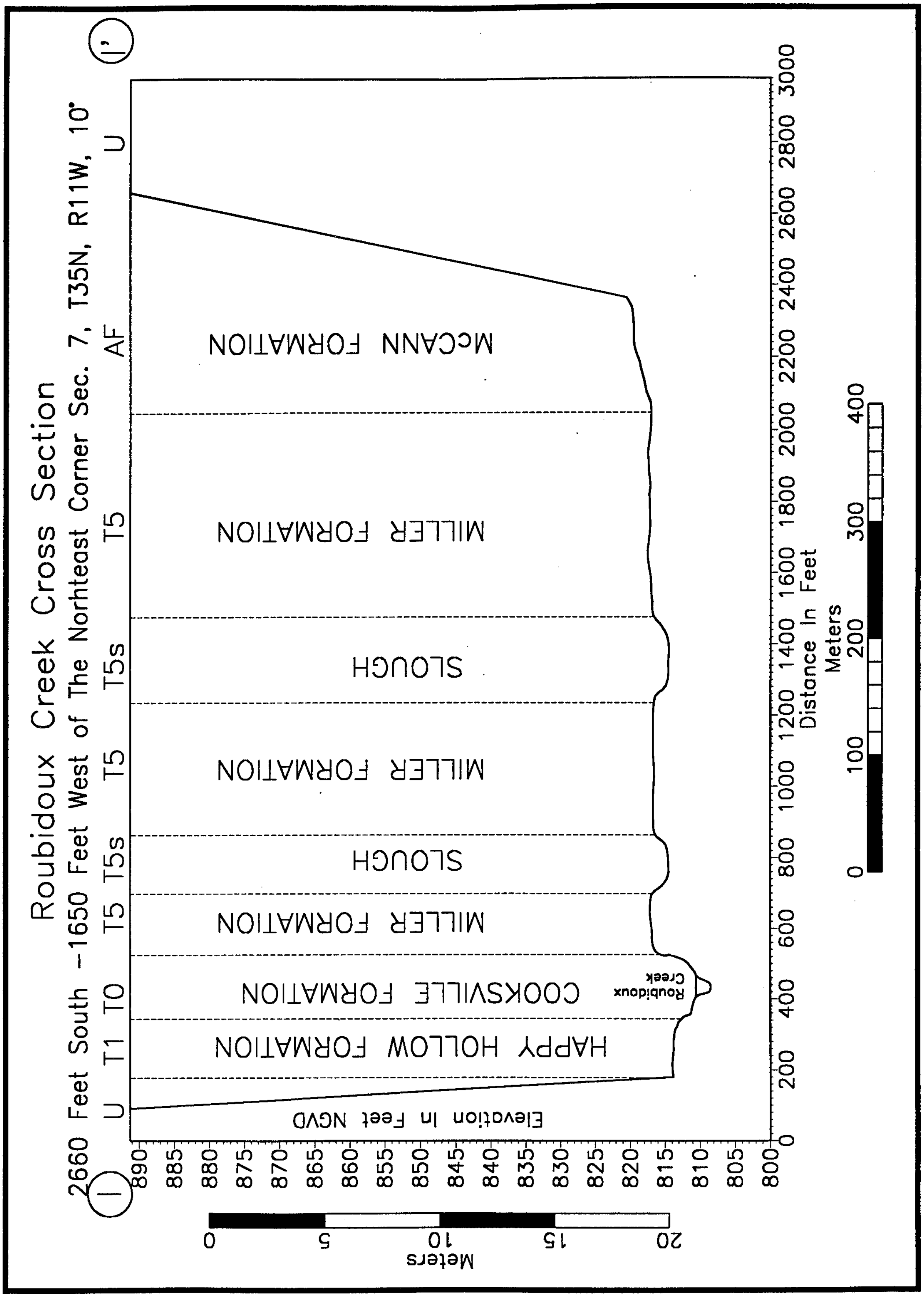
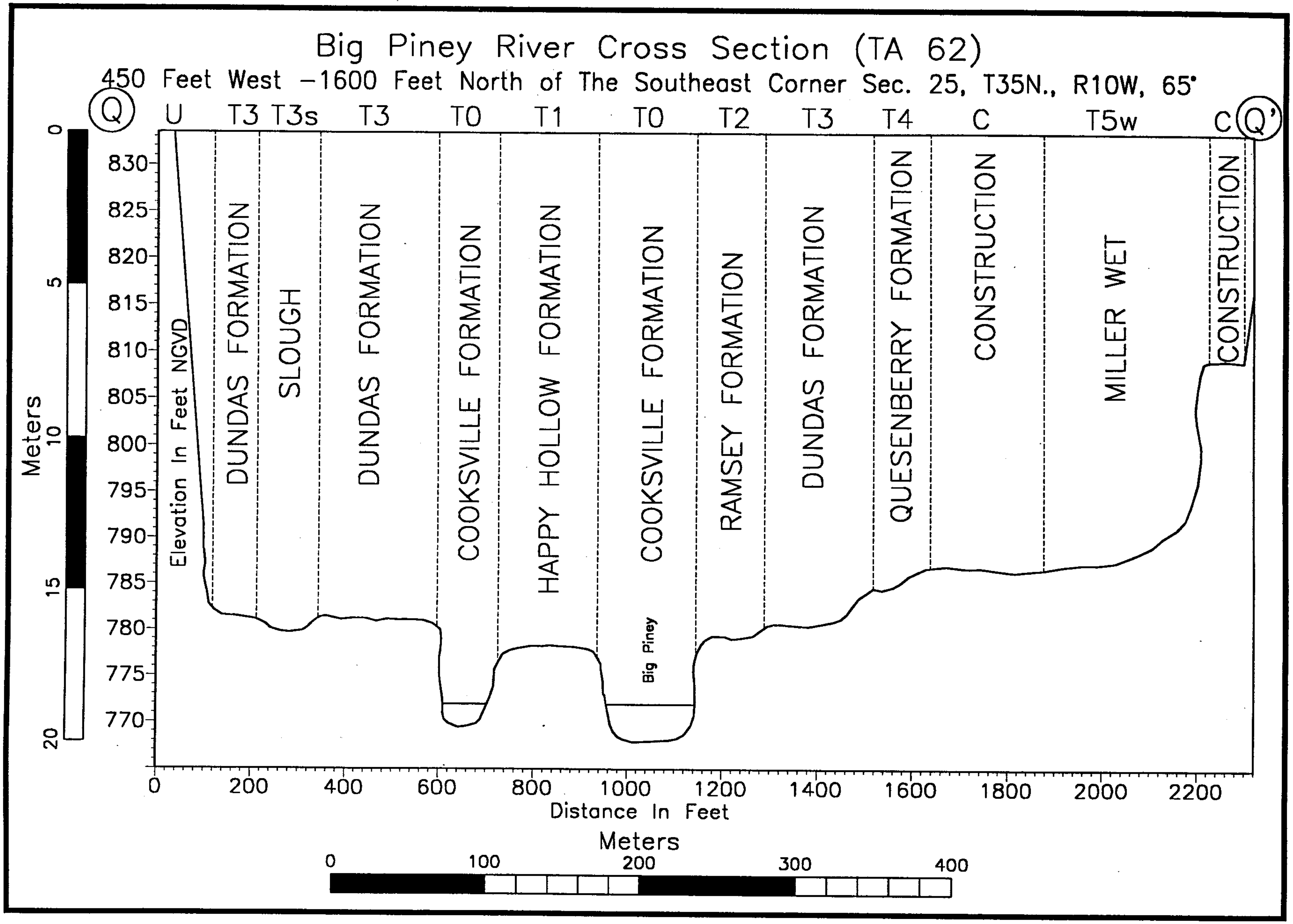
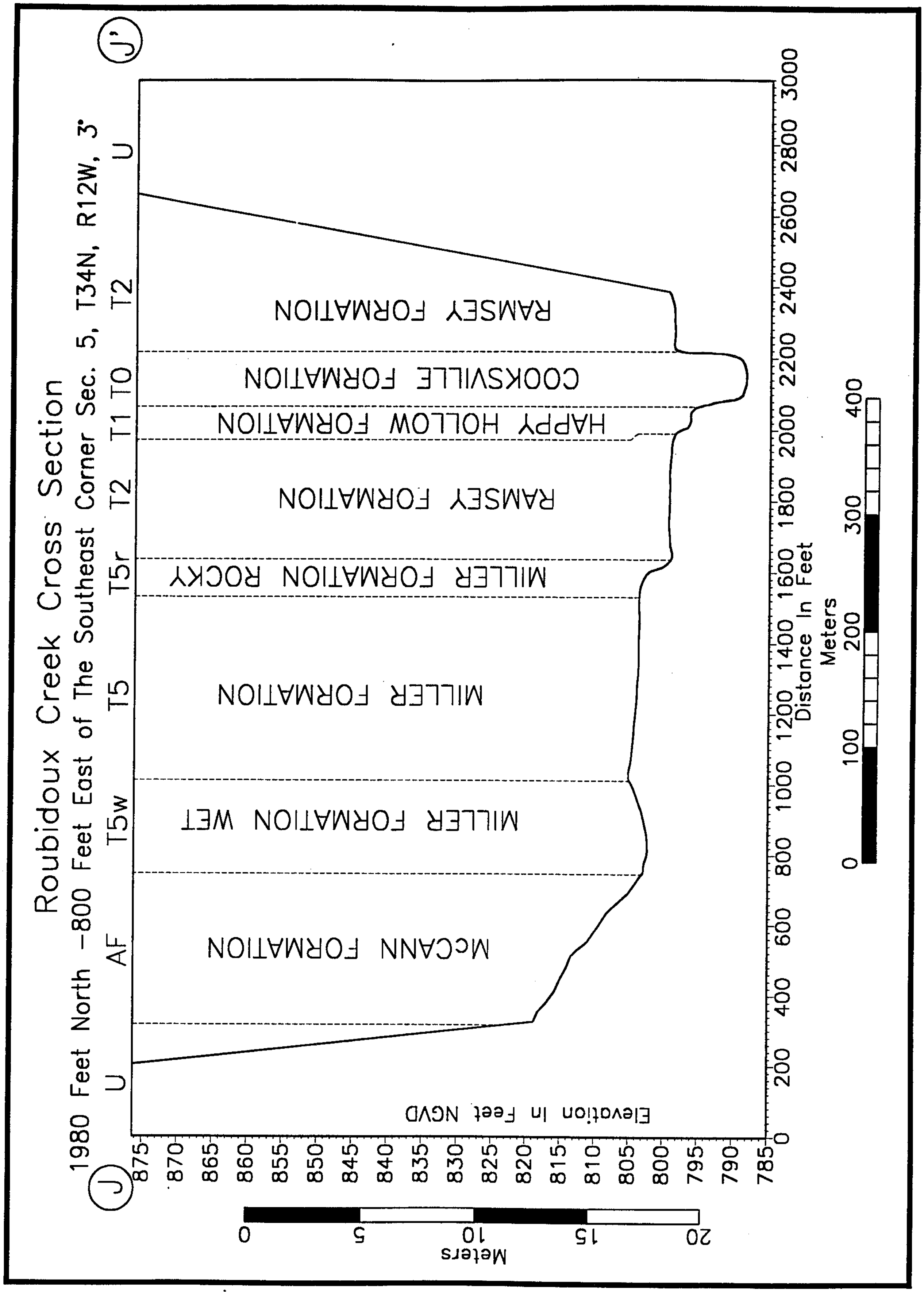

Roubidoux Creek Cross Section
2660 Feet South -1650 Feet West of The Norhteast Corner Sec. 7, T35N, R11W, 10'
I
I'
U
T1
T0
T5
T5s
T5
T5s
T5
AF
U
HAPPY HOLLOW FORMATION
COOKSVILLE FORMATION
Roubidoux Creek
MILLER FORMATION
SLOUGH
MILLER FORMATION
SLOUGH
MILLER FORMATION
McCANN FORMATION
Elevation In Feet NGVD
Distance In Feet
Meters
Meters

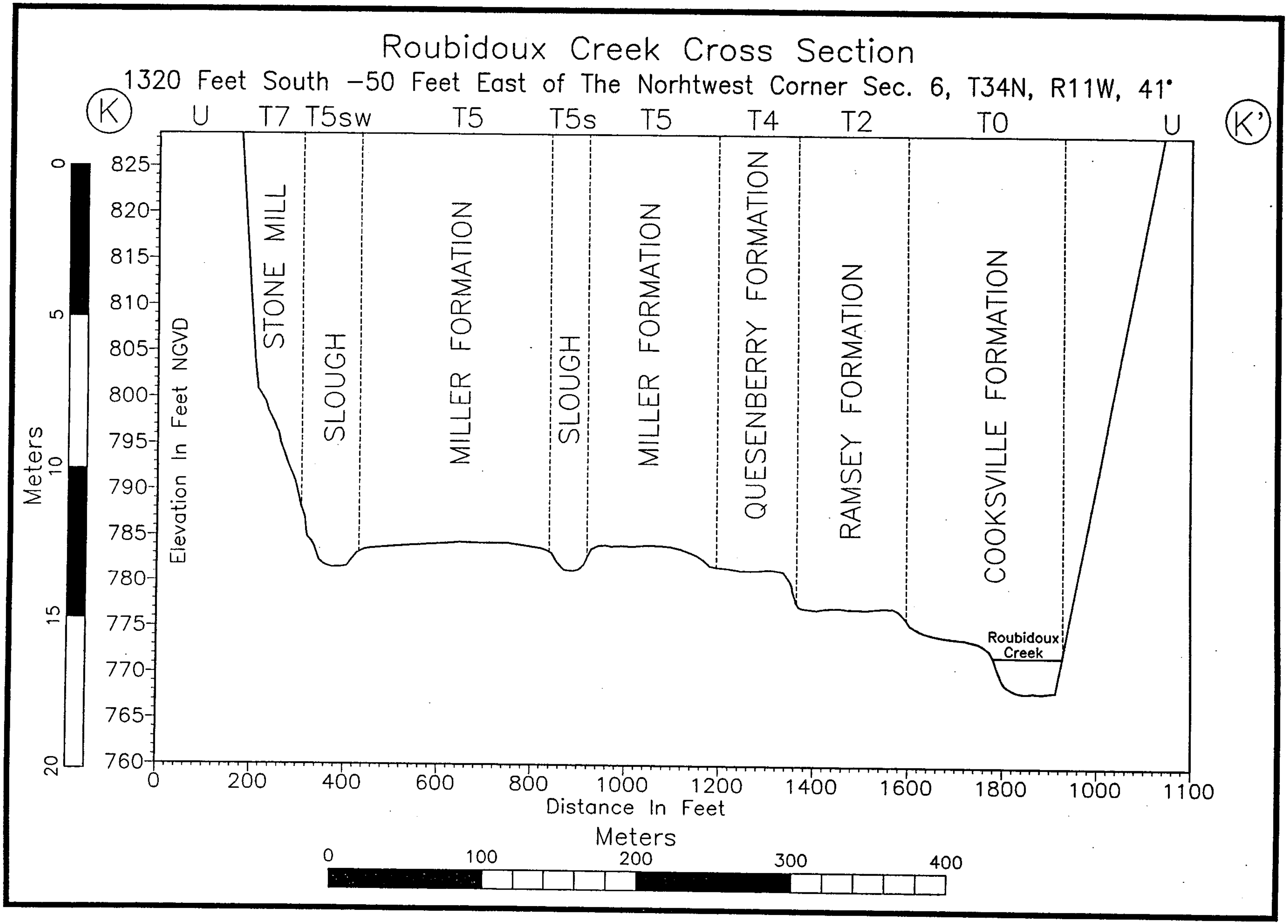
Plate 10


Big Piney River Cross Section (TA 62)
450 Feet West -1600 Feet North of The Southeast Corner Sec. 25, T35N., R10W, 65°
Q
U
T3
T3s
T3
T0
T1
T0
T2
T3
T4
C
T5w
C
Q'
DUNDAS FORMATION
SLOUGH
DUNDAS FORMATION
COOKSVILLE FORMATION
HAPPY HOLLOW FORMATION
COOKSVILLE FORMATION
Big Piney
RAMSEY FORMATION
DUNDAS FORMATION
QUESENBERRY FORMATION
CONSTRUCTION
MILLER WET
CONSTRUCTION
Elevation In Feet NGVD
830
825
820
815
810
805
800
795
790
785
780
775
770
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
Distance In Feet
Meters
0
5
10
15
20
Meters
0
100
200
300
400



Roubidoux Creek Cross Section
1980 Feet North -800 Feet East of The Southeast Corner Sec. 5, T34N, R12W, 3°
J
J'
U
AF
T5w
T5
T5r
T2
T1
T0
T2
U
McCANN FORMATION
MILLER FORMATION WET
MILLER FORMATION
MILLER FORMATION ROCKY
RAMSEY FORMATION
HAPPY HOLLOW FORMATION
COOKSVILLE FORMATION
RAMSEY FORMATION
Elevation In Feet NGVD
875 870 865 860 855 850 845 840 835 830 825 820 815 810 805 800 795 790 785
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600 2800 3000
Distance In Feet
Meters
0 100 200 300 400
Meters
0 5 10 15 20

Plate 12



Roubidoux Creek Cross Section
1320 Feet South -50 Feet East of The Norhtwest Corner Sec. 6, T34N, R11W, 41°
K
K'
U
T7
T5sw
T5
T5s
T5
T4
T2
T0
U
STONE MILL
SLOUGH
MILLER FORMATION
SLOUGH
MILLER FORMATION
QUESENBERRY FORMATION
RAMSEY FORMATION
COOKSVILLE FORMATION
Roubidoux Creek
Elevation In Feet NGVD
825
820
815
810
805
800
795
790
785
780
775
770
765
760
Distance In Feet
0
200
400
600
800
1000
1200
1400
1600
1800
1000
1100
Meters
0
5
10
15
20
Meters
0
100
200
300
400

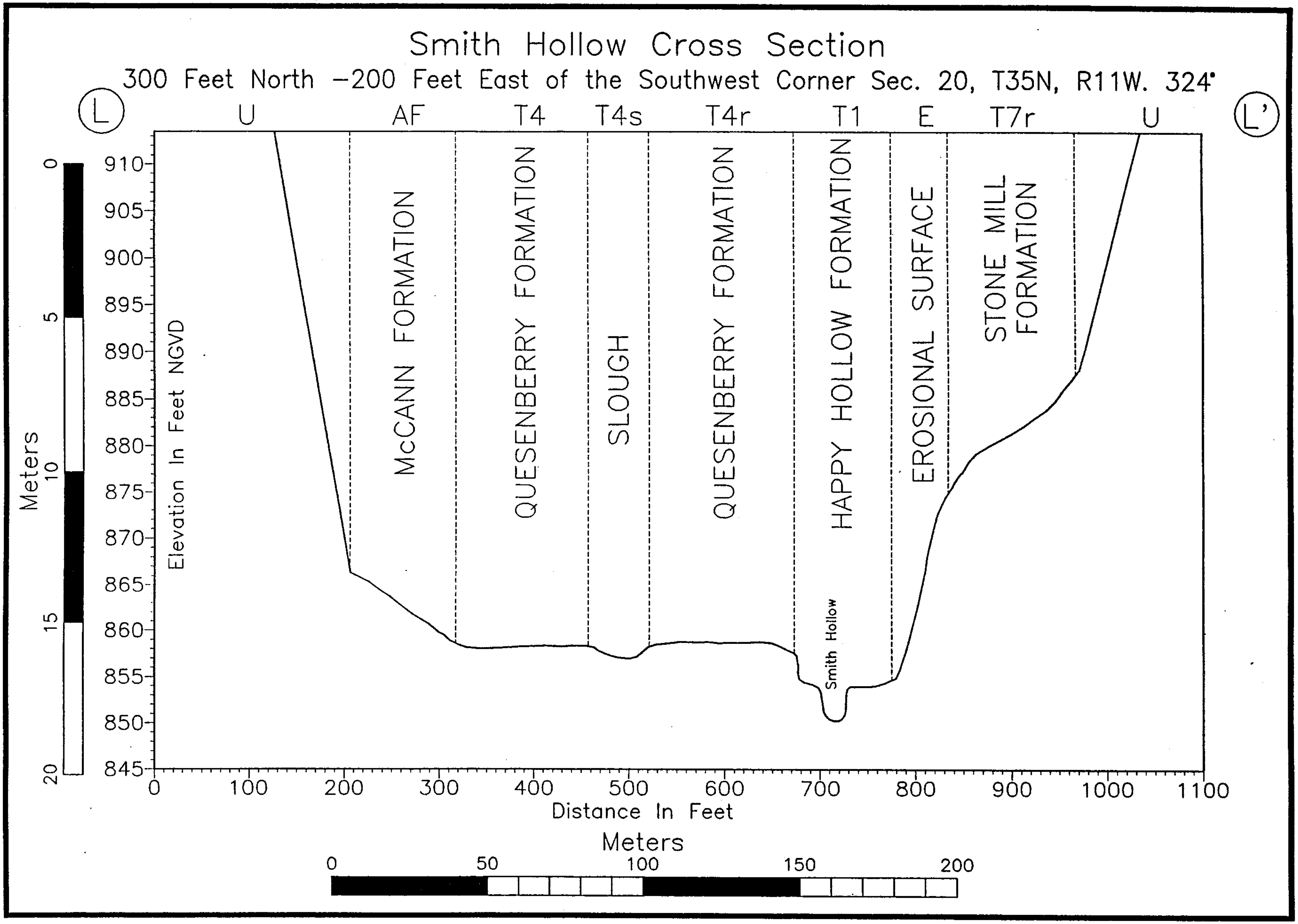
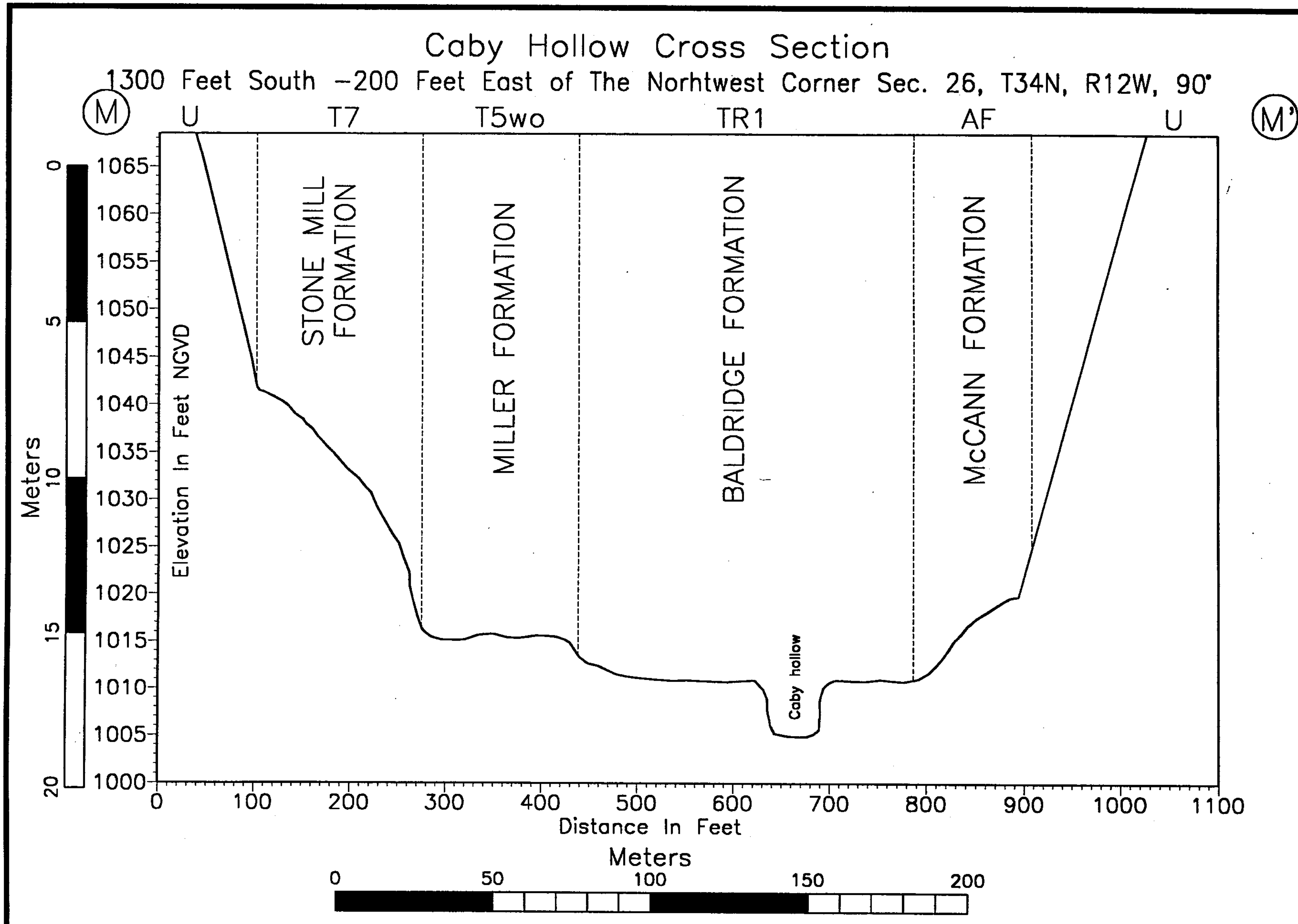

Smith Hollow Cross Section
300 Feet North -200 Feet East of the Southwest Corner Sec. 20, T35N, R11W. 324°
L
L'
U
AF
T4
T4s
T4r
T1
E
T7r
U
McCANN FORMATION
QUESENBERRY FORMATION
SLOUGH
QUESENBERRY FORMATION
HAPPY HOLLOW FORMATION
EROSIONAL SURFACE
STONE MILL FORMATION
Smith Hollow
Elevation In Feet NGVD
910
905
900
895
890
885
880
875
870
865
860
855
850
845
0
100
200
300
400
500
600
700
800
900
1000
1100
Distance In Feet
Meters
0
5
10
15
20
Meters
0
50
100
150
200

Plate 14


Caby Hollow Cross Section
1300 Feet South -200 Feet East of The Norhtwest Corner Sec. 26, T34N, R12W, 90°
M
M'
U
T7
T5wo
TR1
AF
U
STONE MILL FORMATION
MILLER FORMATION
BALDRIDGE FORMATION
McCANN FORMATION
Caby hollow
Elevation In Feet NGVD
1065
1060
1055
1050
1045
1040
1035
1030
1025
1020
1015
1010
1005
1000
Meters
0
5
10
15
20
Distance In Feet
0
100
200
300
400
500
600
700
800
900
1000
1100
Meters
0
50
100
150
200

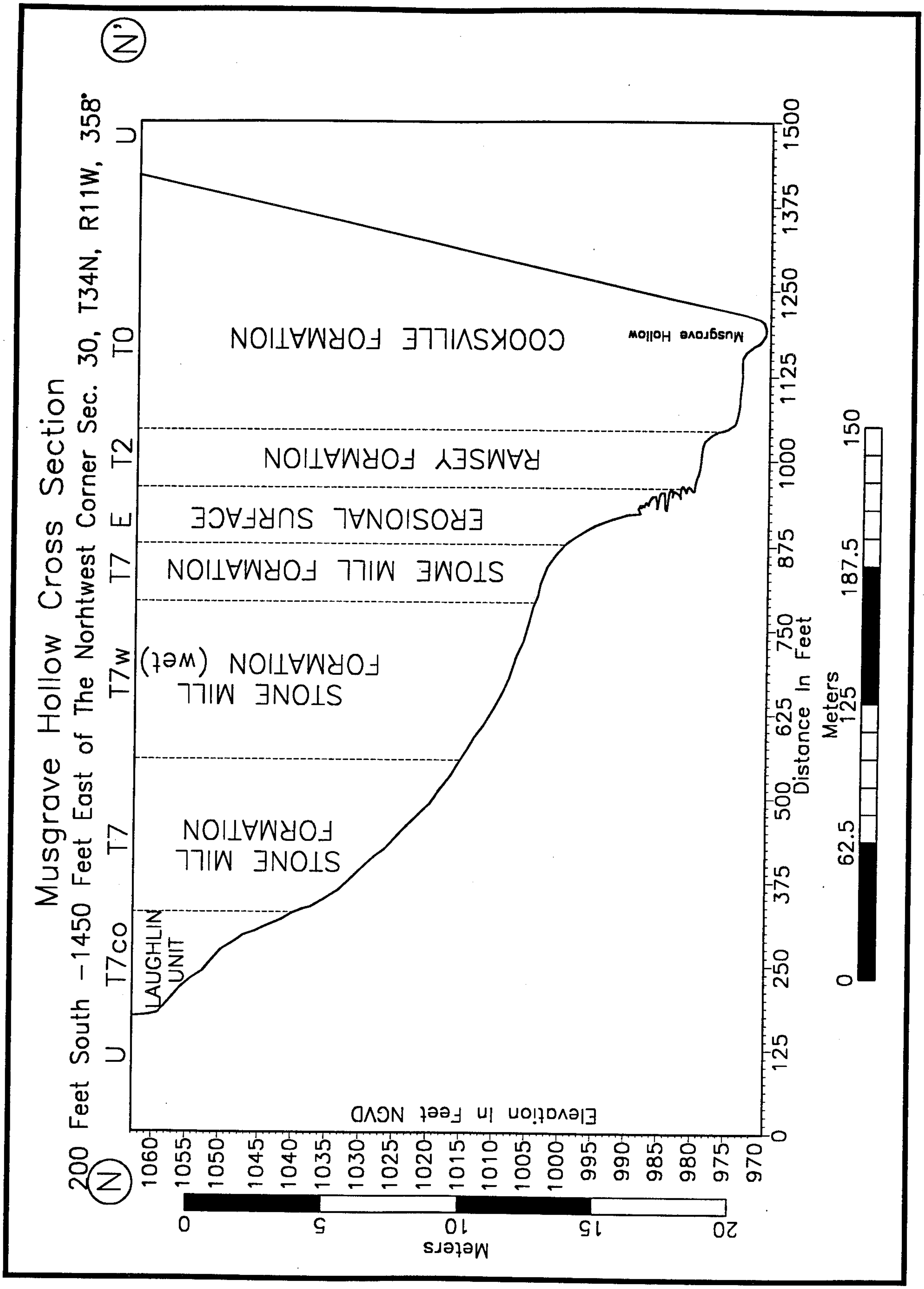
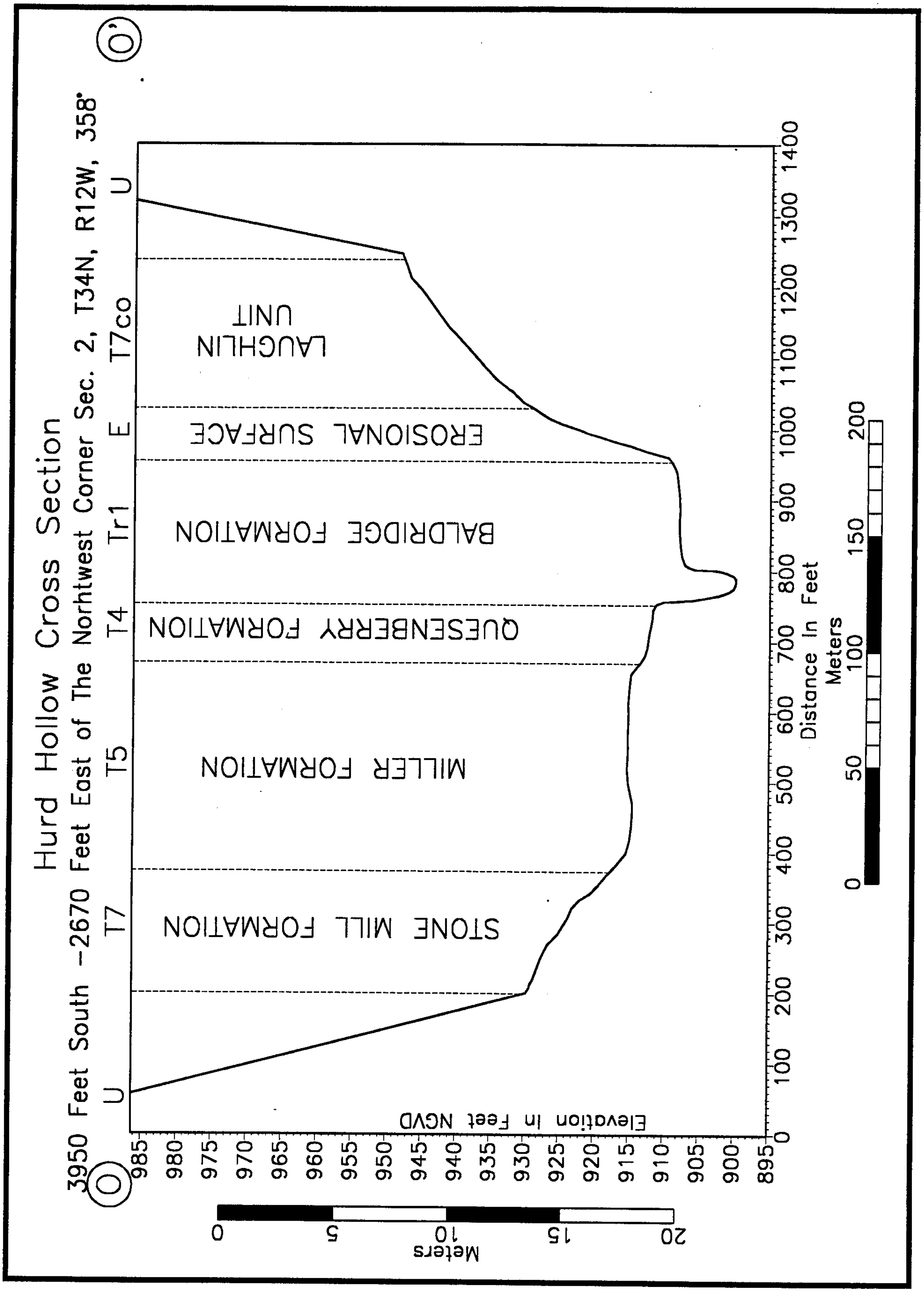
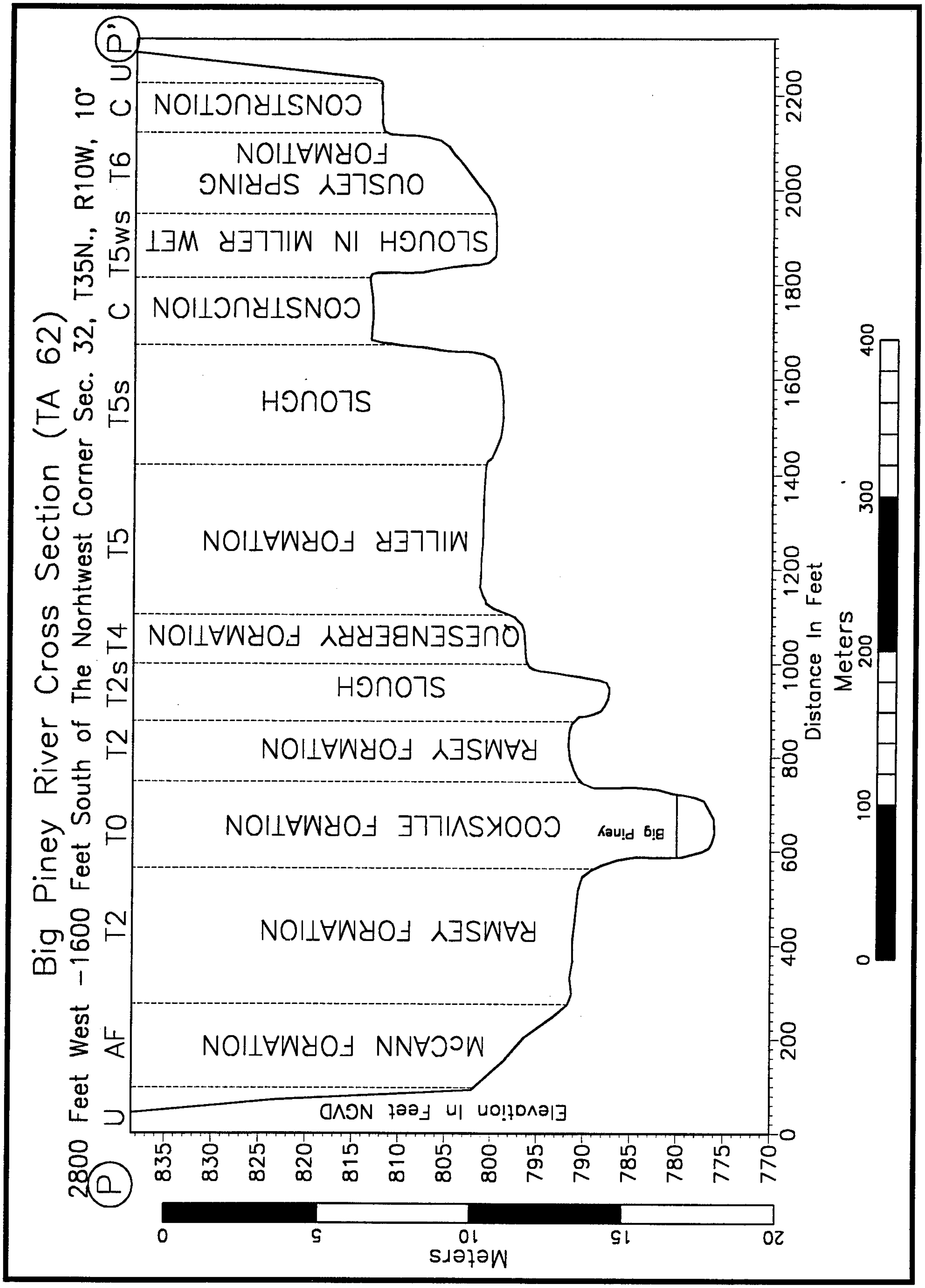

Musgrave Hollow Cross Section
200 Feet South -1450 Feet East of The Northwest Corner Sec. 30, T34N, R11W, 358°
N
N'
U
T7co
T7
T7w
T7
E
T2
T0
U
LAUGHLIN UNIT
STONE MILL FORMATION
STONE MILL FORMATION (wet)
STOME MILL FORMATION
EROSIONAL SURFACE
RAMSEY FORMATION
COOKSVILLE FORMATION
Musgrave Hollow
Elevation In Feet NGVD
1060
1055
1050
1045
1040
1035
1030
1025
1020
1015
1010
1005
1000
995
990
985
980
975
970
0
125
250
375
500
625
750
875
1000
1125
1250
1375
1500
Distance In Feet
Meters
0
62.5
125
187.5
150
Meters
0
5
10
15
20

Plate 16



Hurd Hollow Cross Section
3950 Feet South -2670 Feet East of The Norhtwest Corner Sec. 2, T34N, R12W, 358°
O
O'
U
T7
T5
T4
Tr1
E
T7co
U
STONE MILL FORMATION
MILLER FORMATION
QUESENBERRY FORMATION
BALDRIDGE FORMATION
EROSIONAL SURFACE
LAUGHLIN UNIT
Elevation In Feet NGVD
985
980
975
970
965
960
955
950
945
940
935
930
925
920
915
910
905
900
895
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
Distance In Feet
Meters
0
50
100
150
200
Meters
0
5
10
15
20

Plate 17



Big Piney River Cross Section (TA 62)
2800 Feet West -1600 Feet South of The Norhtwest Corner Sec. 32, T35N., R10W, 10'
P
P'
U
AF
T2
T0
T2
T2s
T4
T5
T5s
C
T5ws
T6
C
U
McCANN FORMATION
RAMSEY FORMATION
COOKSVILLE FORMATION
Big Piney
RAMSEY FORMATION
SLOUGH
QUESENBERRY FORMATION
MILLER FORMATION
SLOUGH
CONSTRUCTION
SLOUGH IN MILLER WET
OUSLEY SPRING FORMATION
CONSTRUCTION
Elevation In Feet NGVD
835
830
825
820
815
810
805
800
795
790
785
780
775
770
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
Distance In Feet
Meters
0
100
200
300
400
Meters
0
5
10
15
20

Plate 18

Big Piney River Cross Section (Golf Course (hole 1))

2200 Feet West -1650 Feet South of The Norhtwest Corner Sec. 30, T35N., R10W, 357°

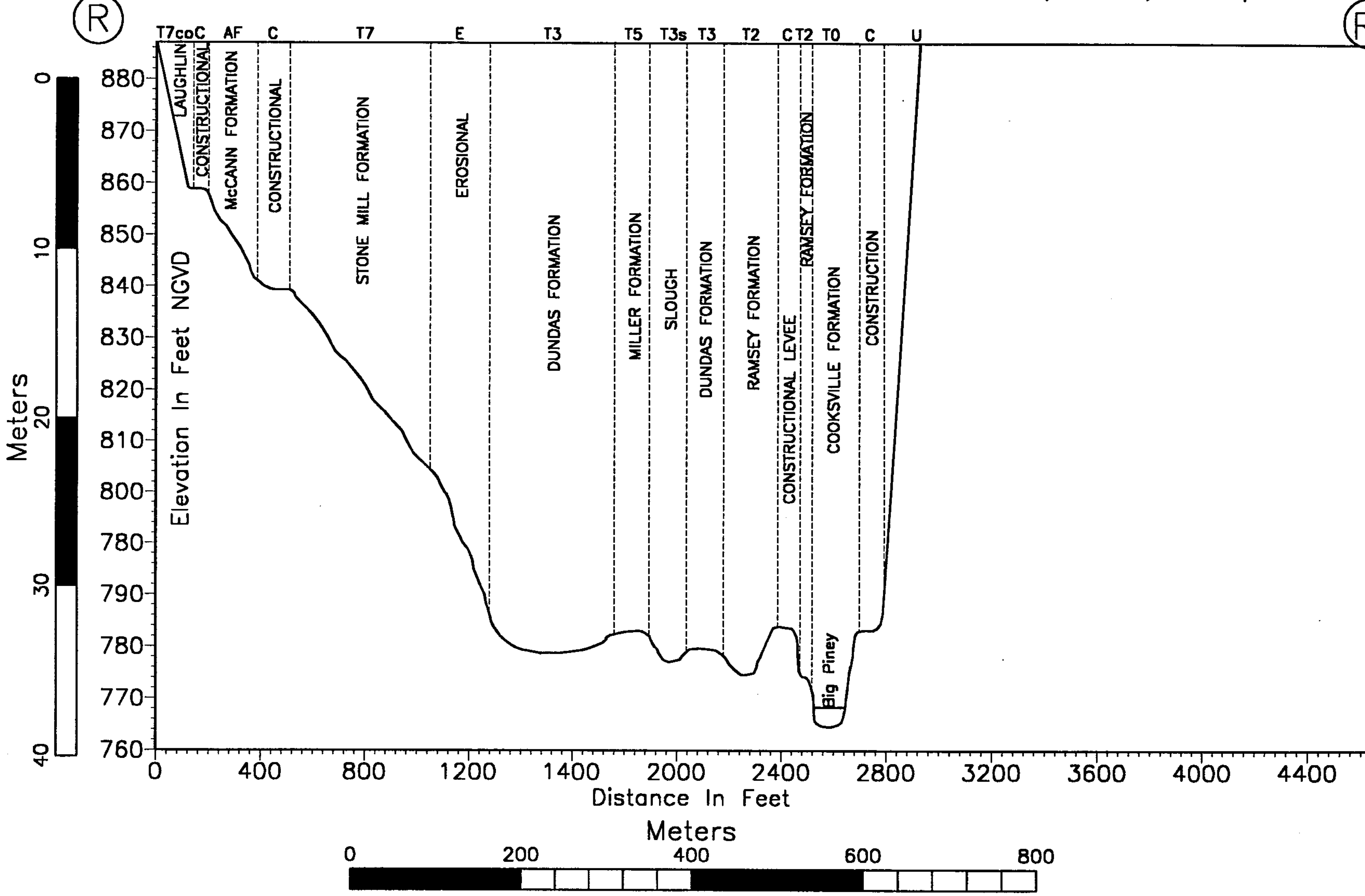


Plate 19

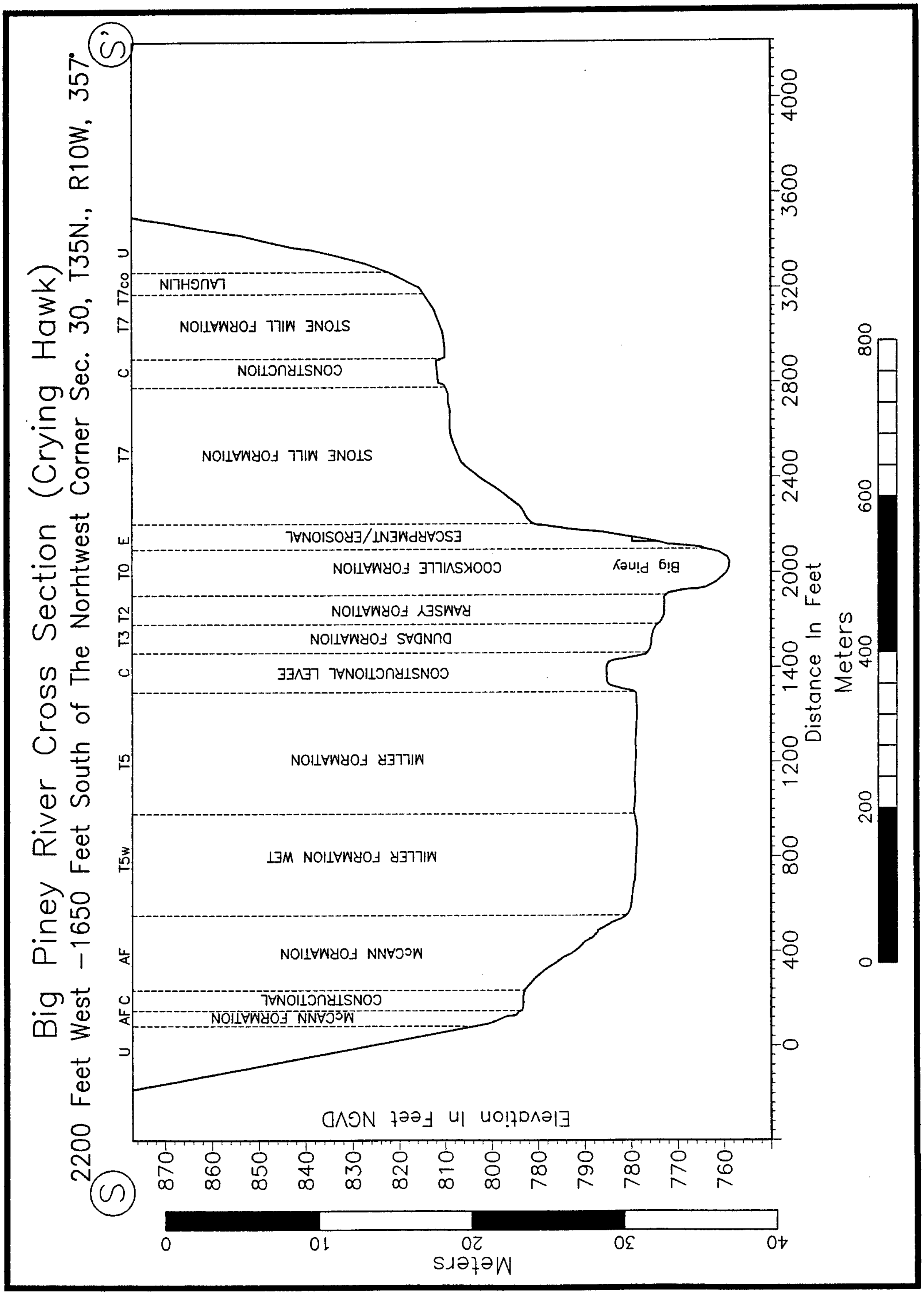
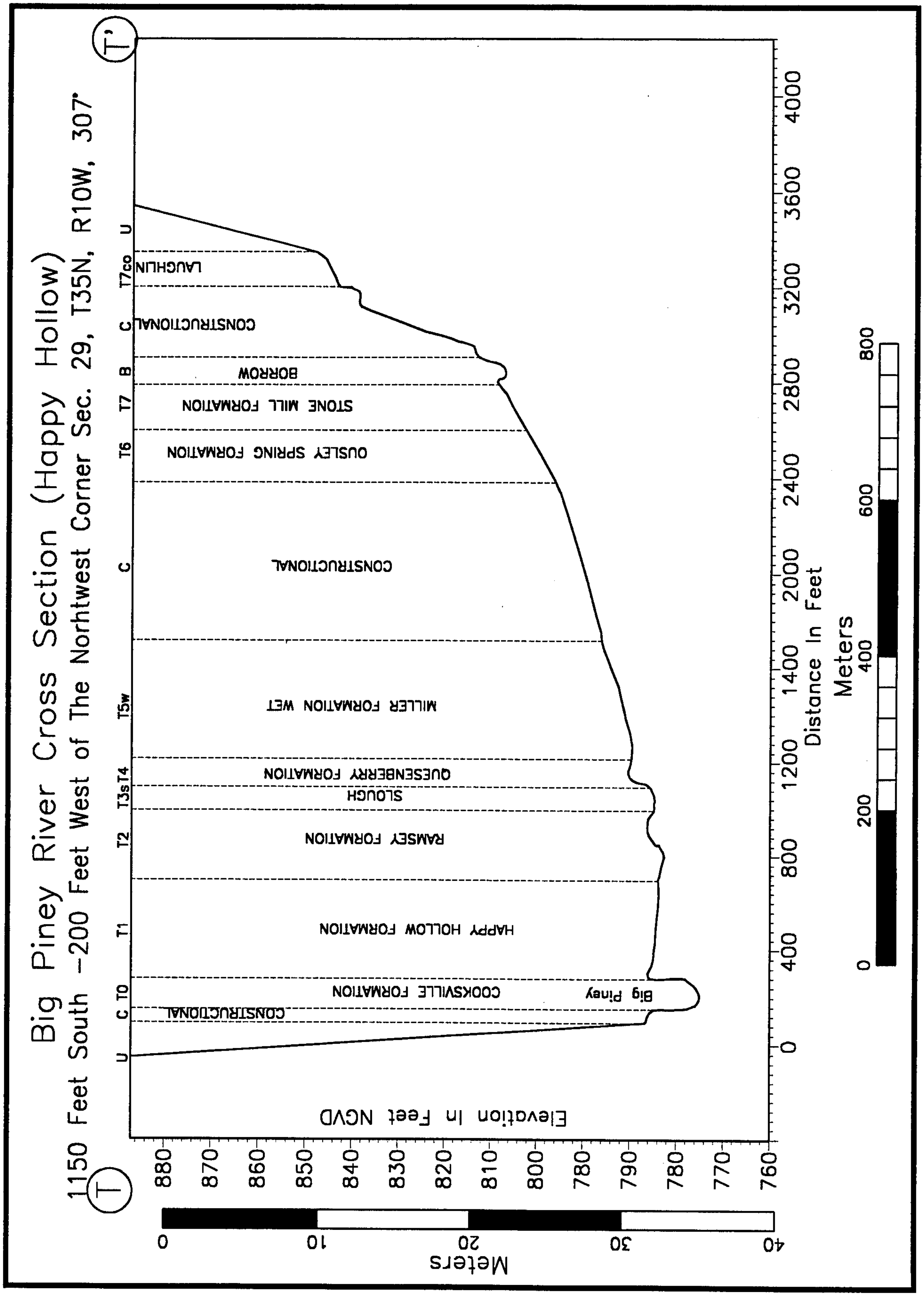

Big Piney River Cross Section (Crying Hawk)
2200 Feet West -1650 Feet South of The Norhtwest Corner Sec. 30, T35N., R10W, 357'
S
S'
U
AF
C
AF
T5w
T5
C
T3
T2
T0
E
T7
C
T7
T7co
U
McCANN FORMATION
CONSTRUCTIONAL
McCANN FORMATION
MILLER FORMATION WET
MILLER FORMATION
CONSTRUCTIONAL LEVEE
DUNDAS FORMATION
RAMSEY FORMATION
COOKSVILLE FORMATION
Big Piney
ESCARPMENT/EROSIONAL
STONE MILL FORMATION
CONSTRUCTION
STONE MILL FORMATION
LAUGHLIN
Elevation In Feet NGVD
870
860
850
840
830
820
810
800
790
780
770
760
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
Distance In Feet
0
200
400
600
800
Meters
0
10
20
30
40
Meters

Plate 20



Big Piney River Cross Section (Happy Hollow)
1150 Feet South -200 Feet West of The Norhtwest Corner Sec. 29, T35N, R10W, 307°
T
T'
Elevation In Feet NGVD
Distance In Feet
Meters
U
C
T0
T1
T2
T3s
T4
T5w
T6
T7
B
T7co
CONSTRUCTIONAL
COOKSVILLE FORMATION
Big Piney
HAPPY HOLLOW FORMATION
RAMSEY FORMATION
SLOUGH
QUESENBERRY FORMATION
MILLER FORMATION WET
OUSLEY SPRING FORMATION
STONE MILL FORMATION
BORROW
LAUGHLIN
880
870
860
850
840
830
820
810
800
790
780
770
760
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
0
10
20
30
40
200
600

Plate 21

Big Piney River Cross Section (Training Lake)

900 Feet East -4350 Feet North of The Southwest Corner Sec. 21, T35N, R10W, 225°

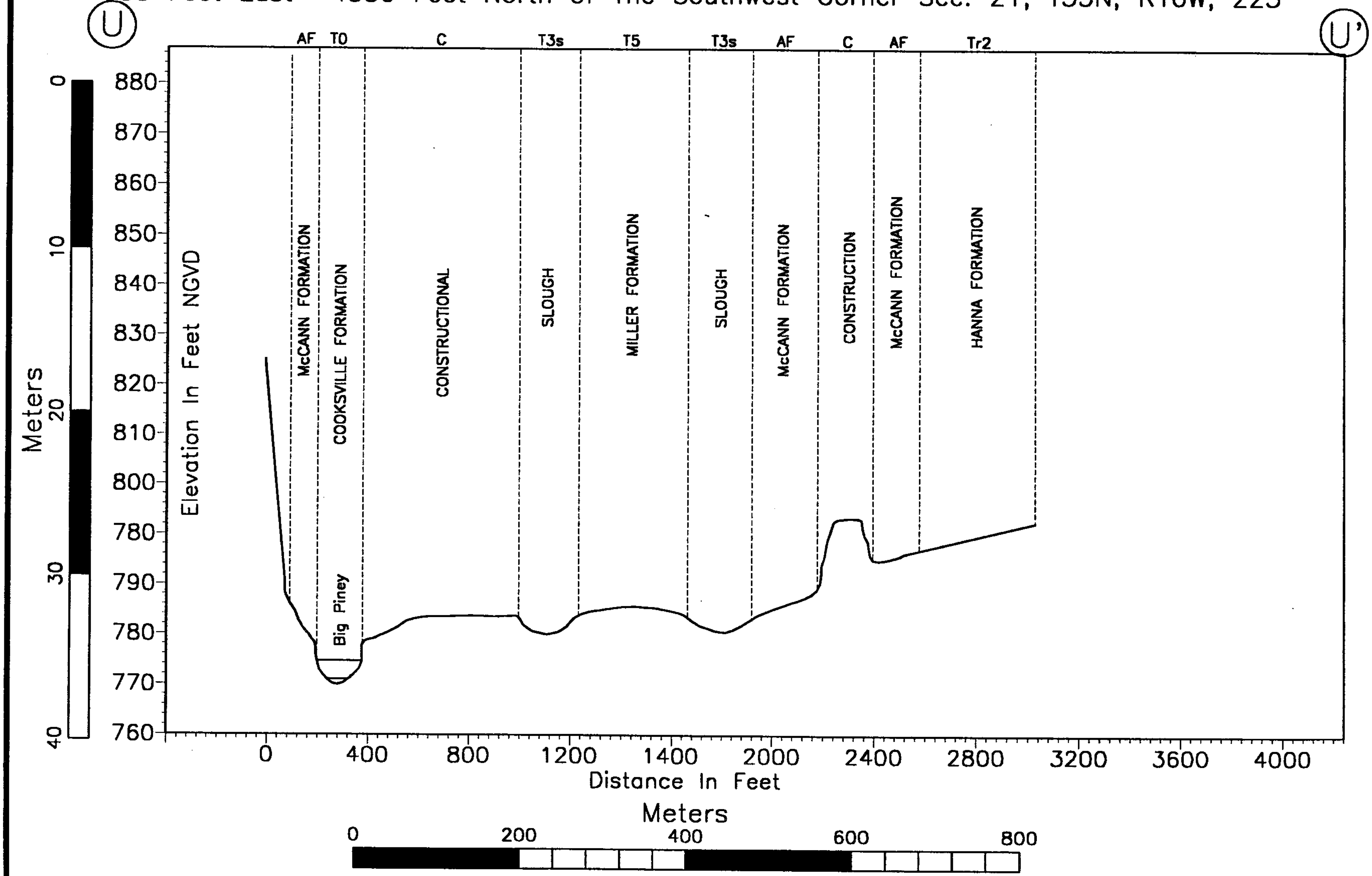
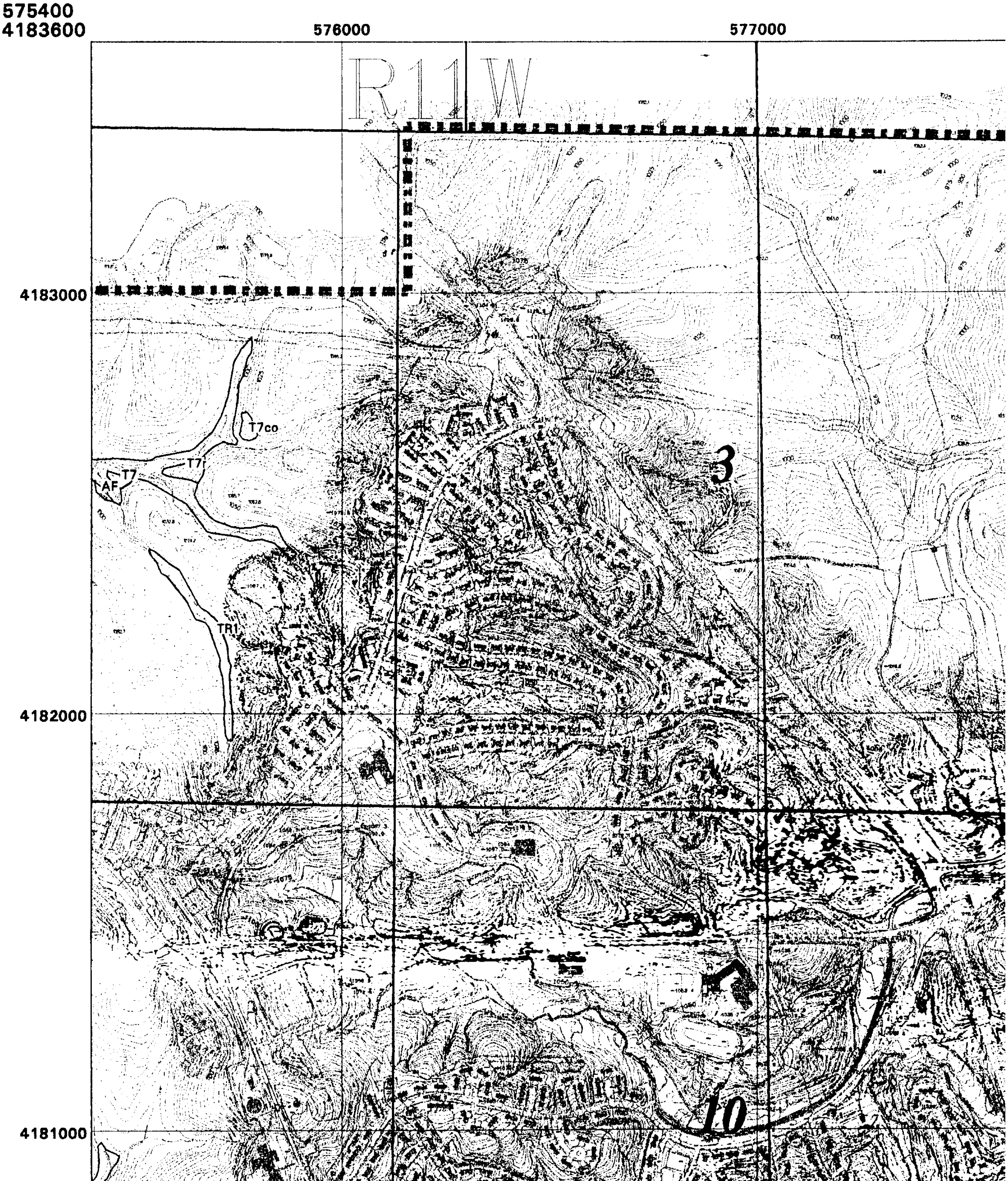
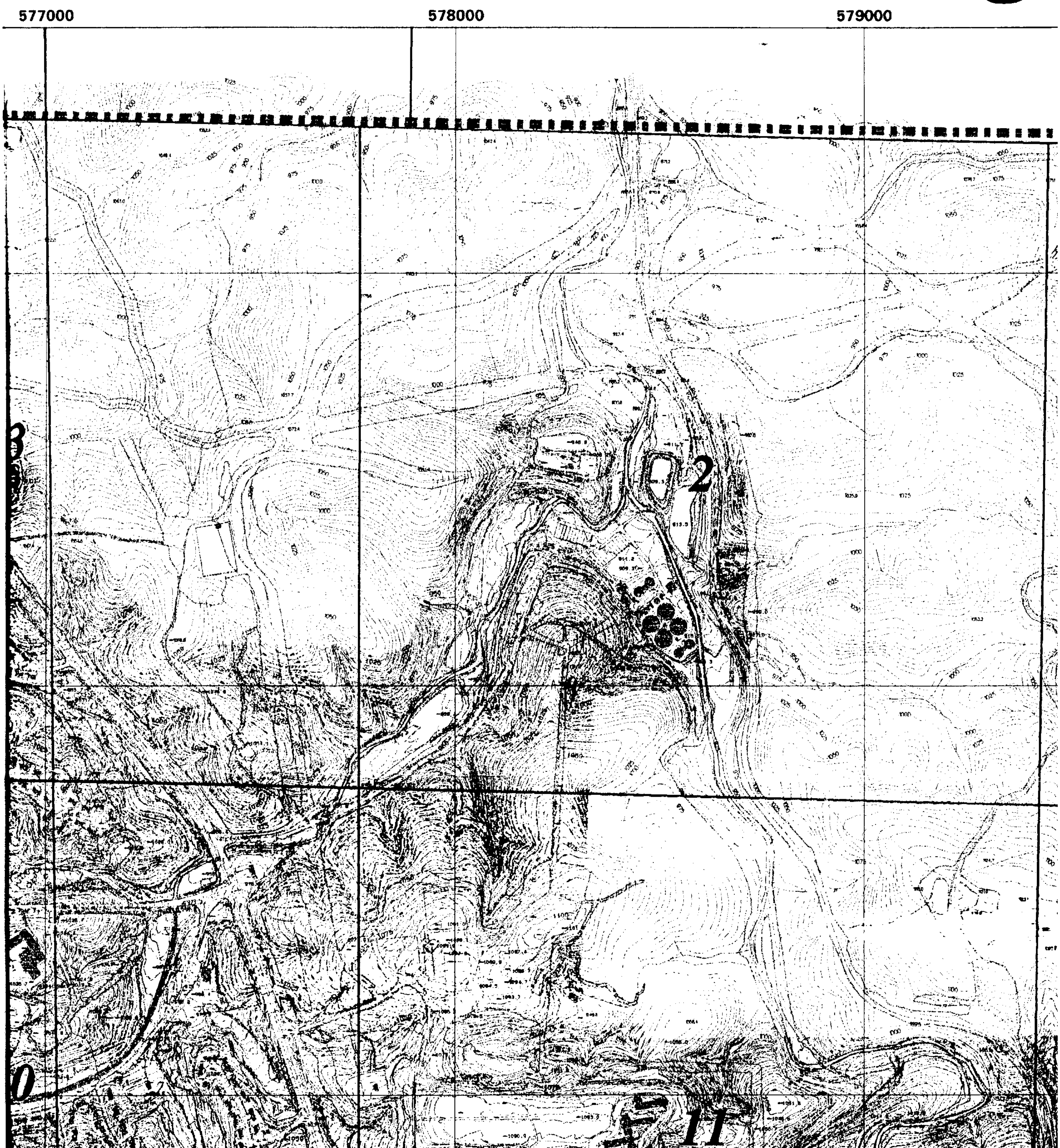


Plate 22

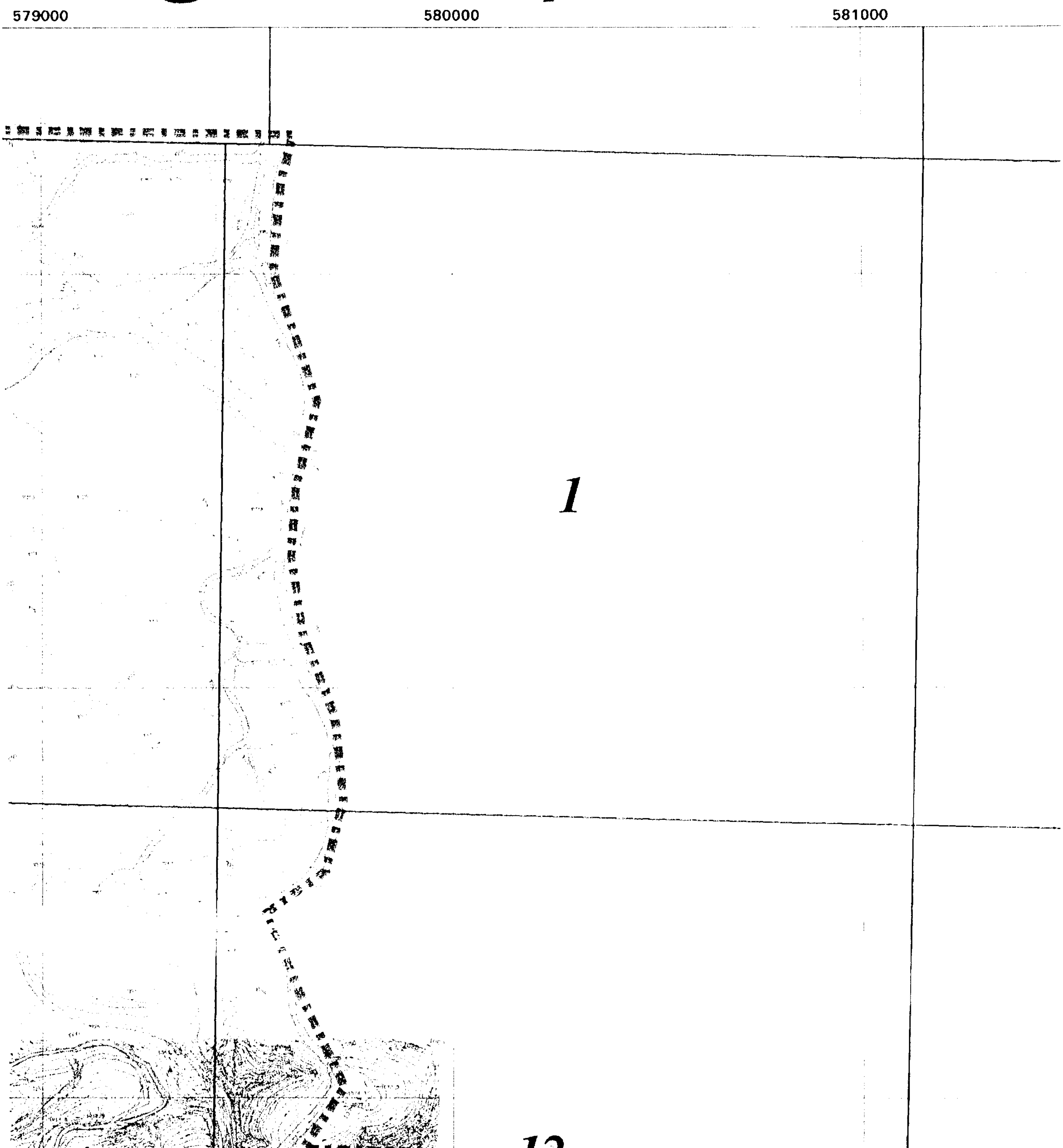


575400
4183600
576000
577000
R11W
4183000
T7co
T7
T7
AF
3
TR1
4182000
10
4181000

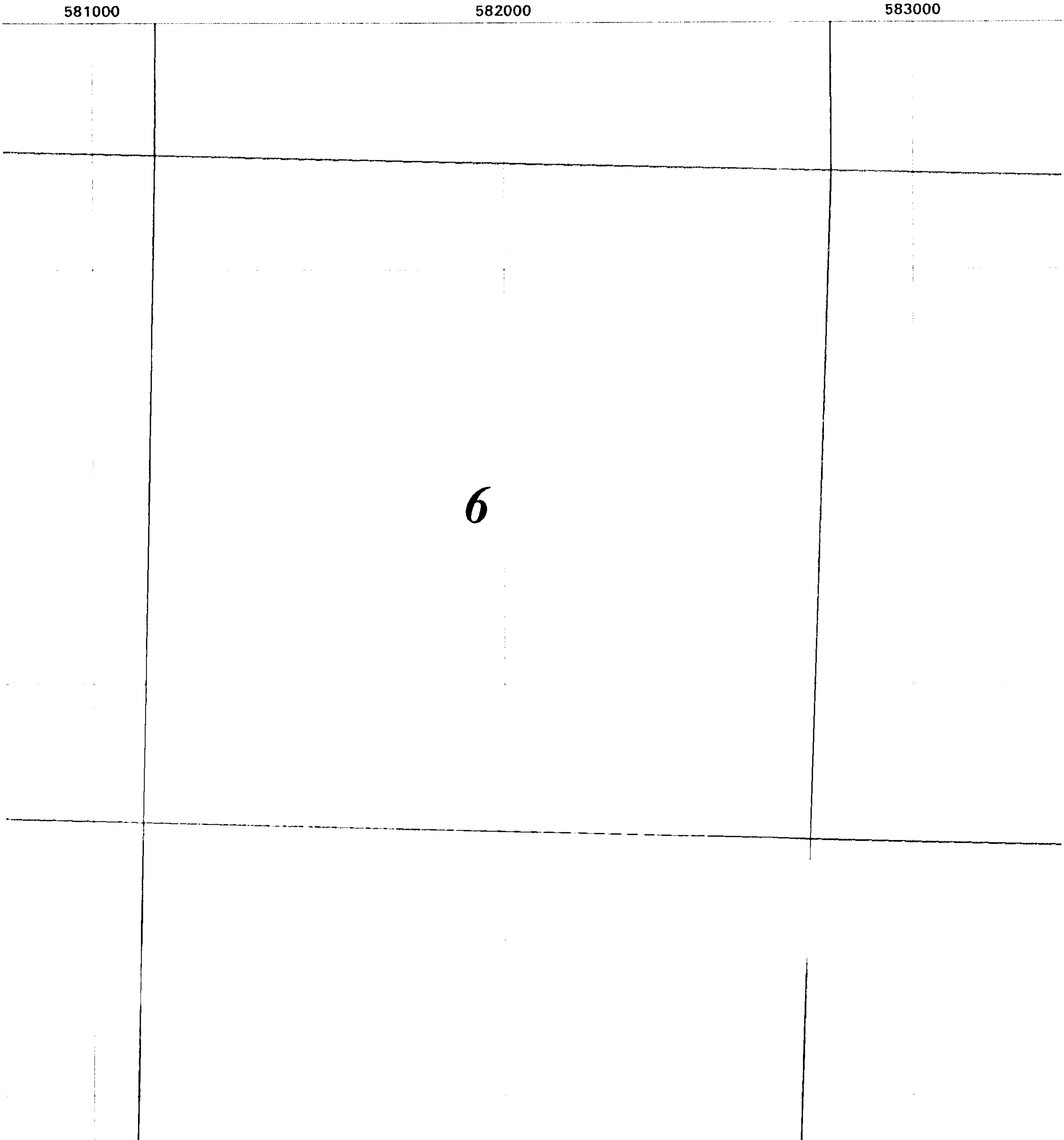
Big

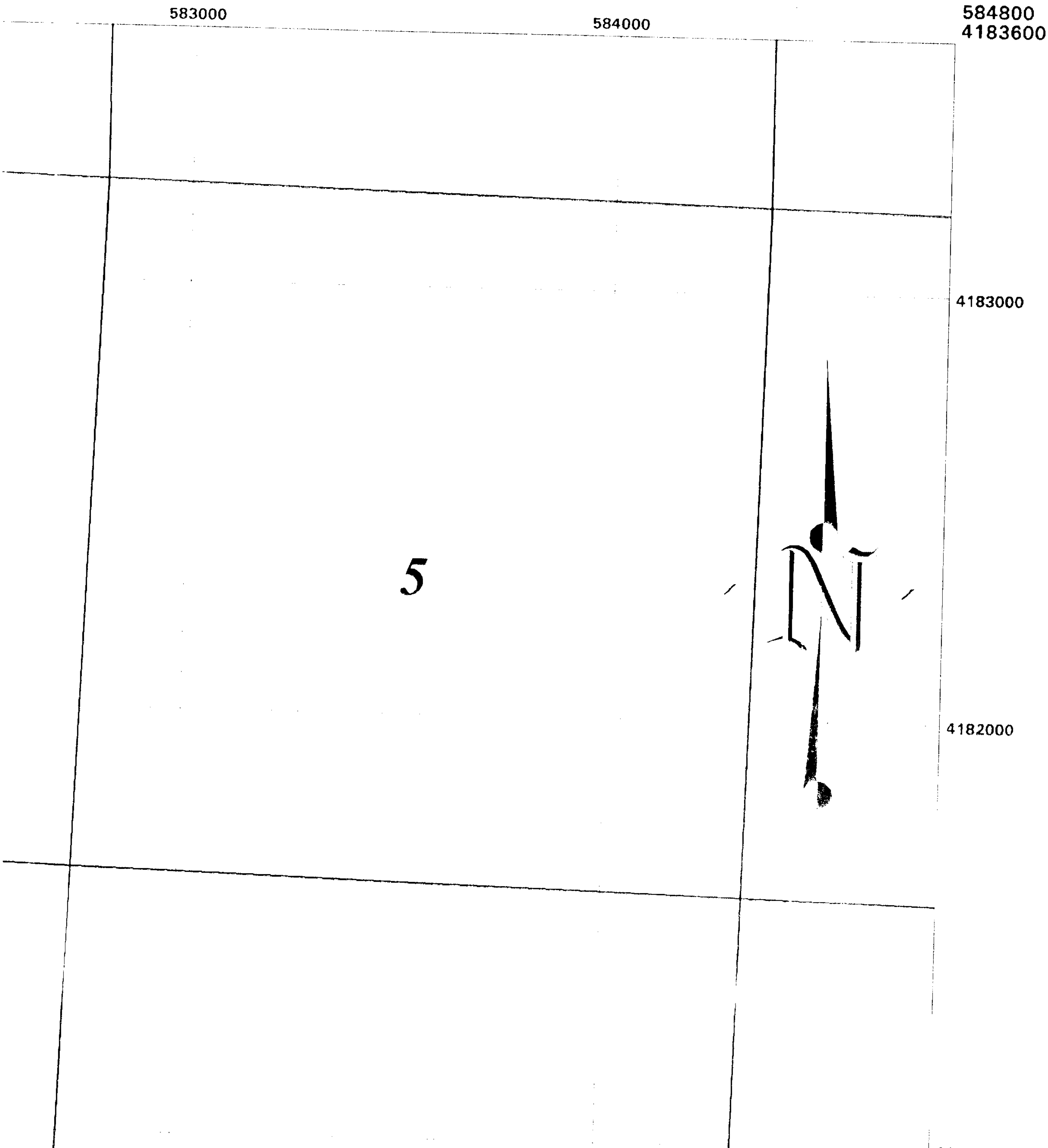


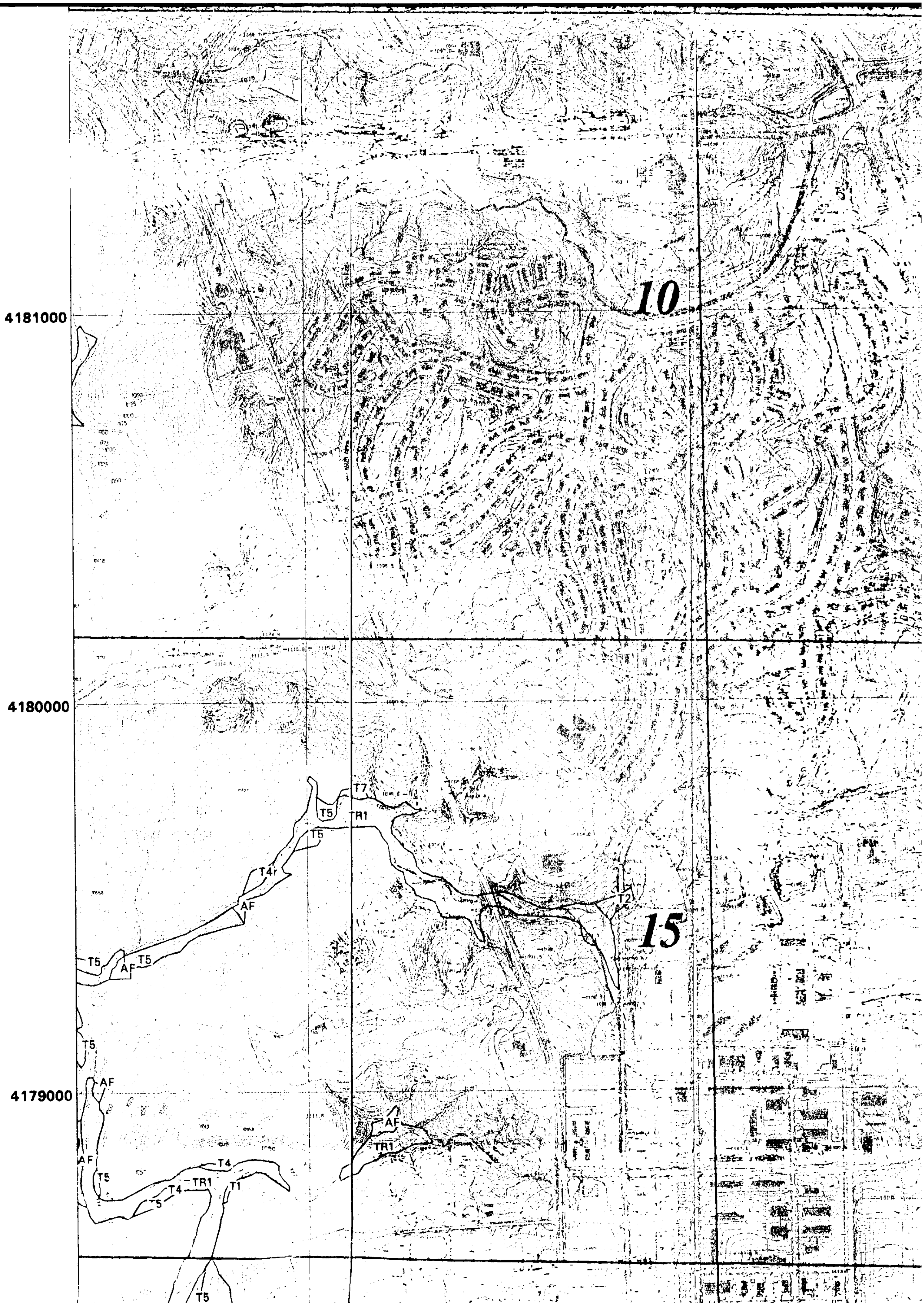
Big Piney River



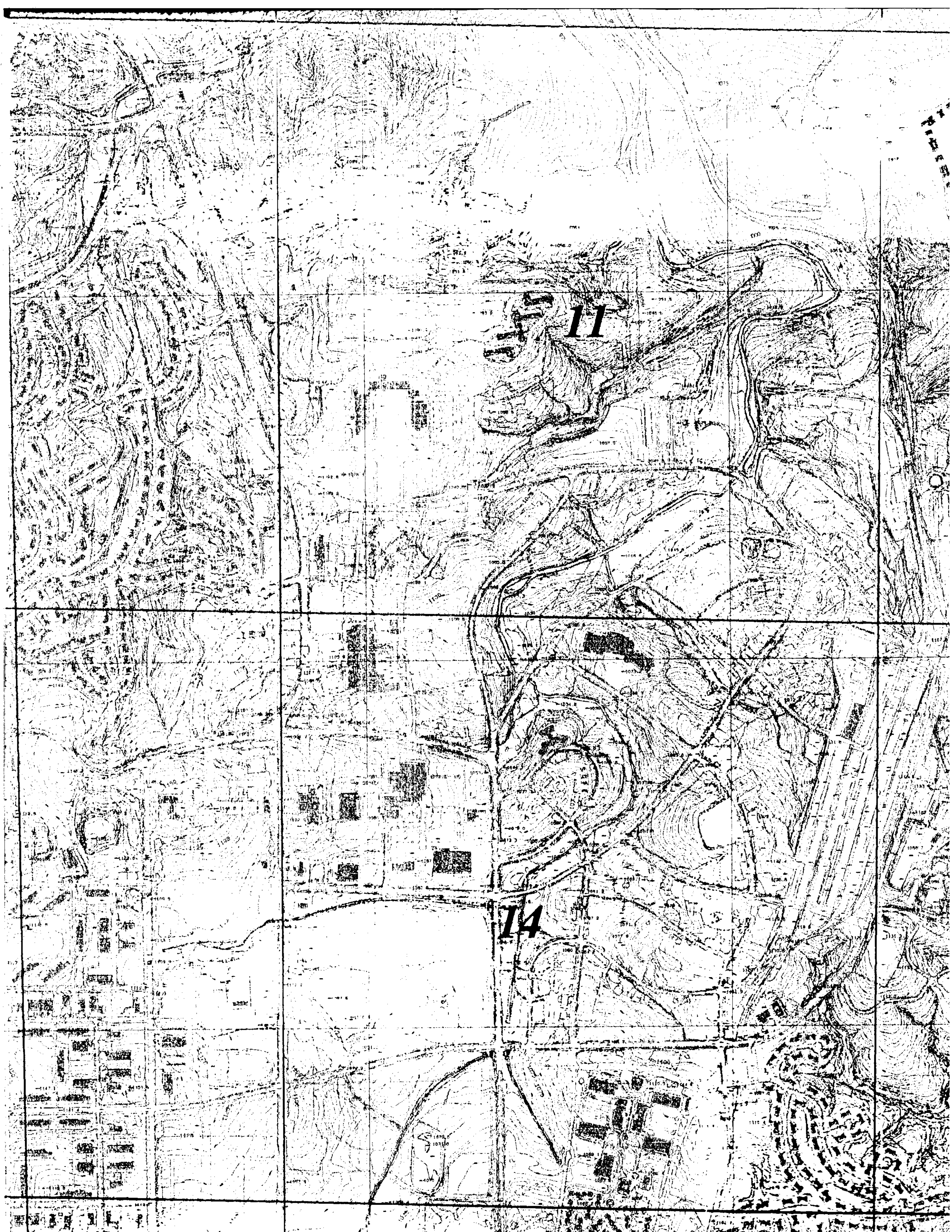
ver

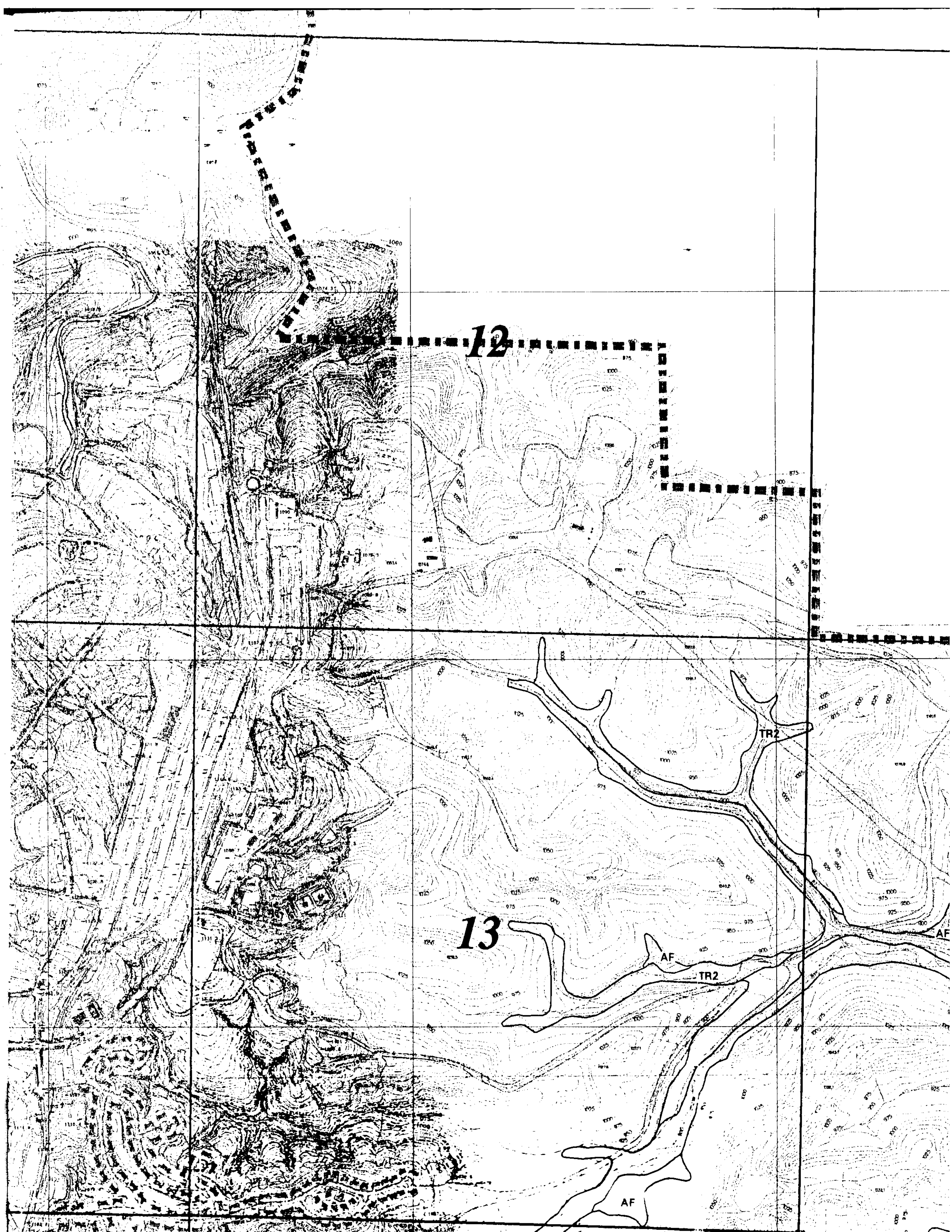


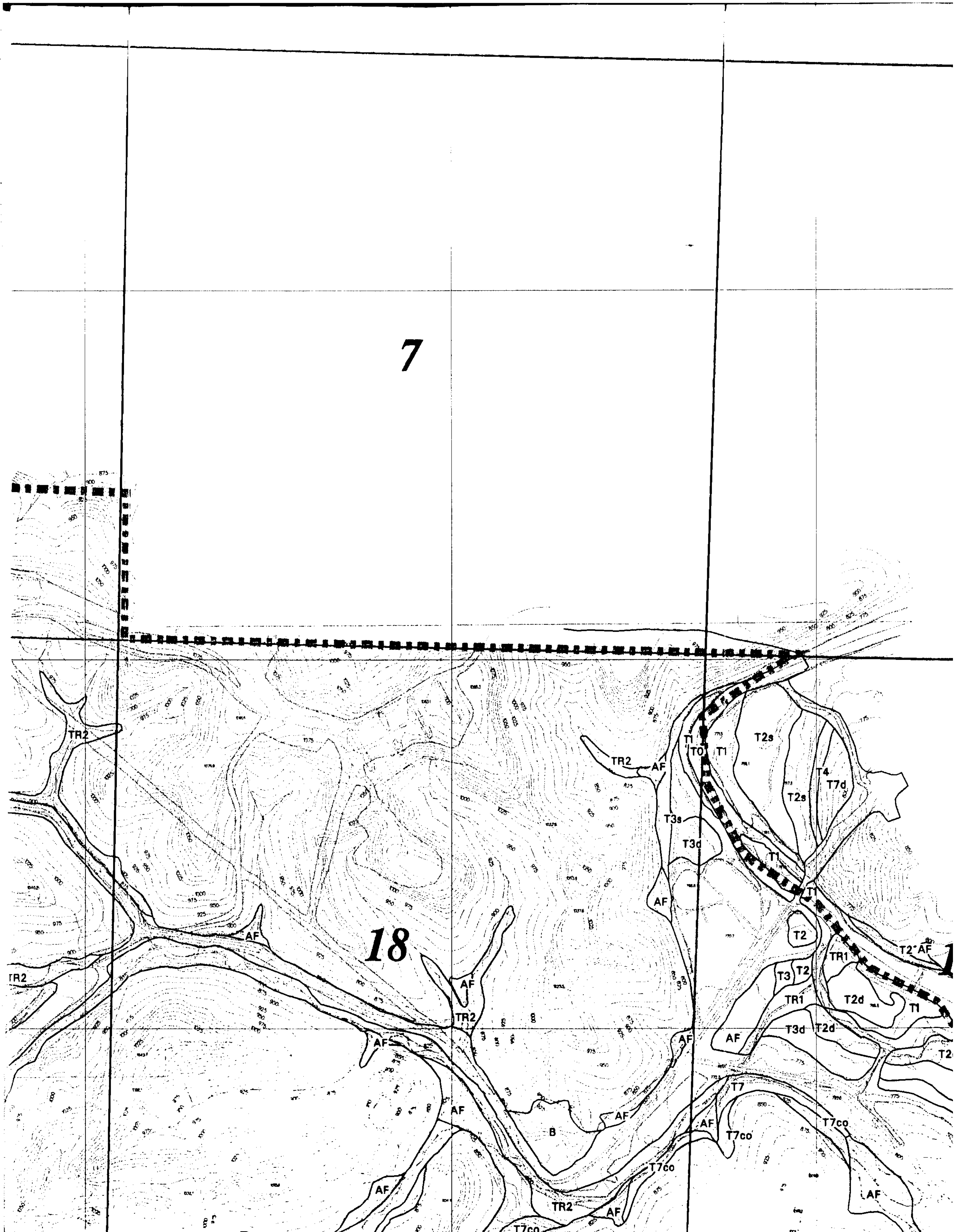

583000
584000
584800
4183600
4183000
4182000
5
N

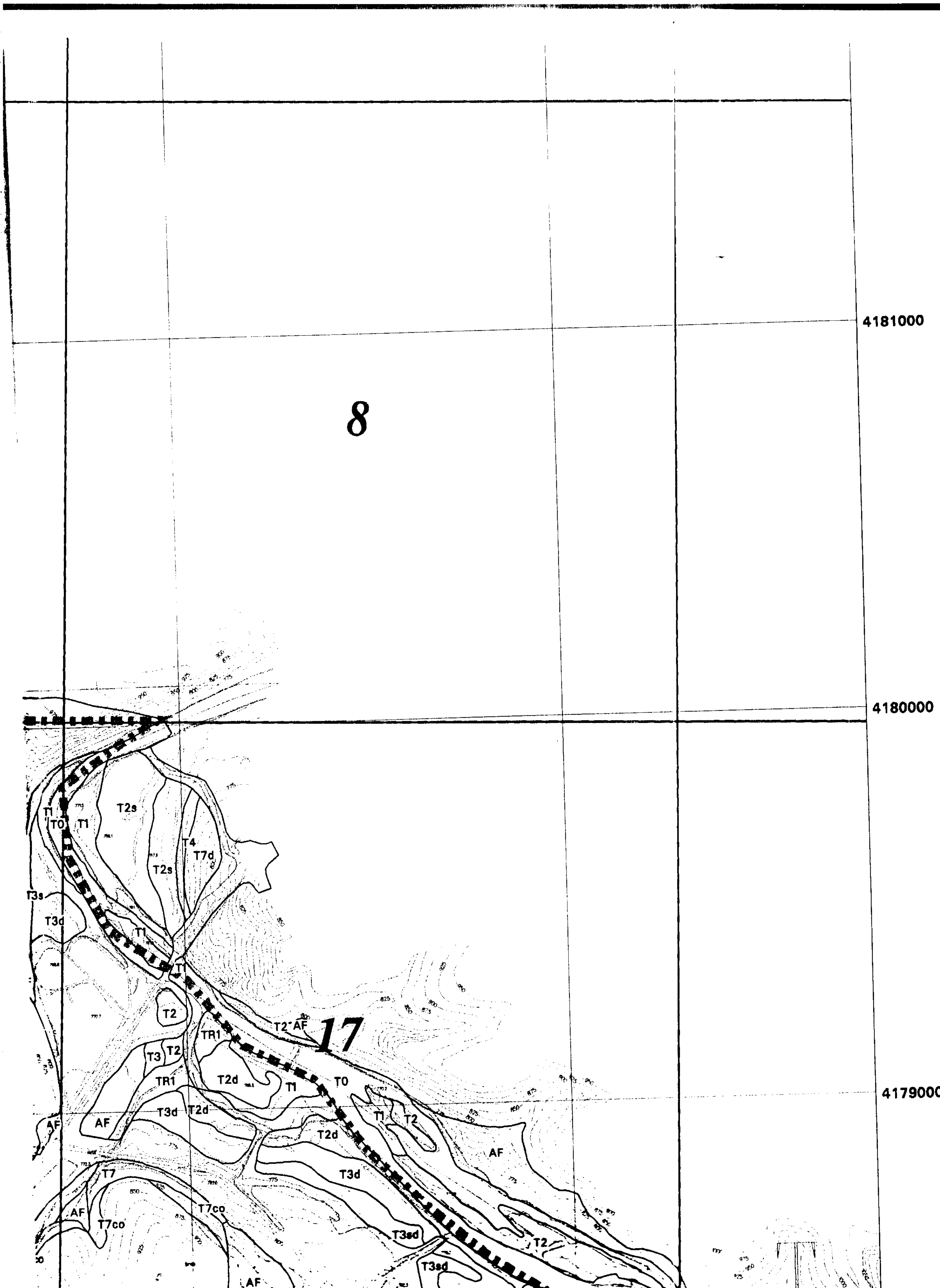


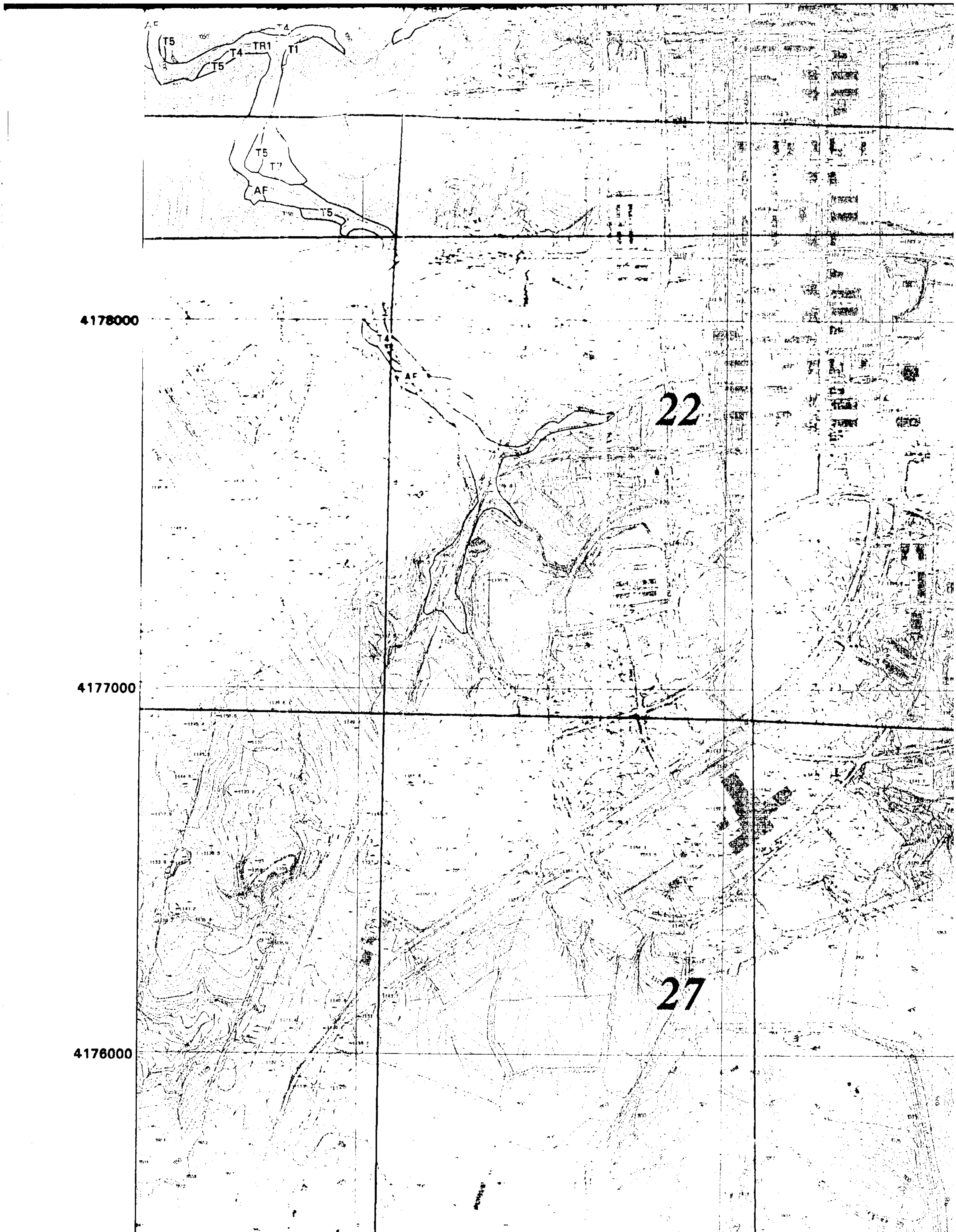
4181000
4180000
4179000
10
15
T7
T5
TR1
T5
T4r
AF
T5
AF
T5
T2
T5
AF
AF
AF
TR1
T4
T5
T4
TR1
T1
T5
T5


11
14

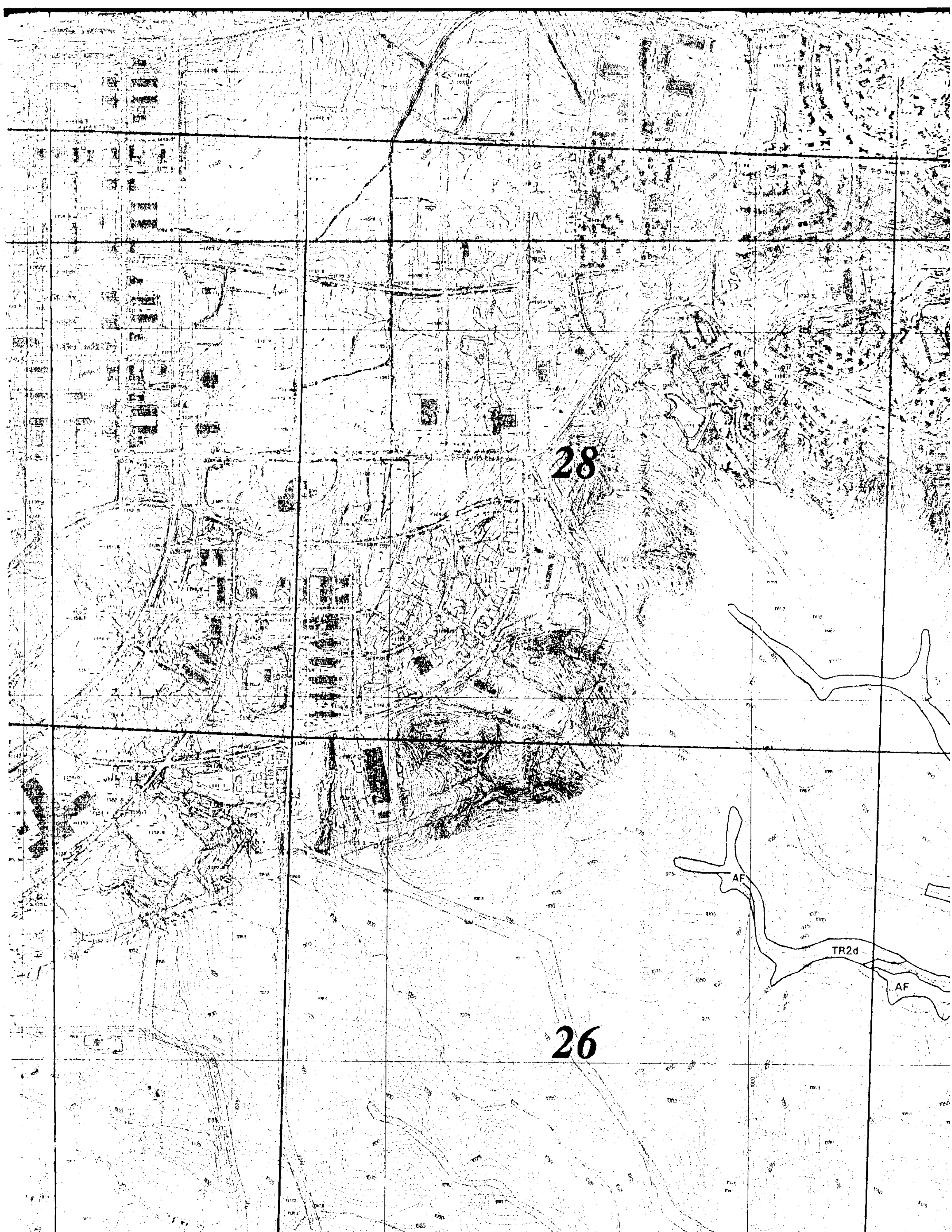

12
13
TR2
AF
TR2
AF
AF


7
18
TR2
AF
TR1
T0
T1
T2
T2s
T2d
T3
T3s
T3d
T4
T7
T7d
T7co
B

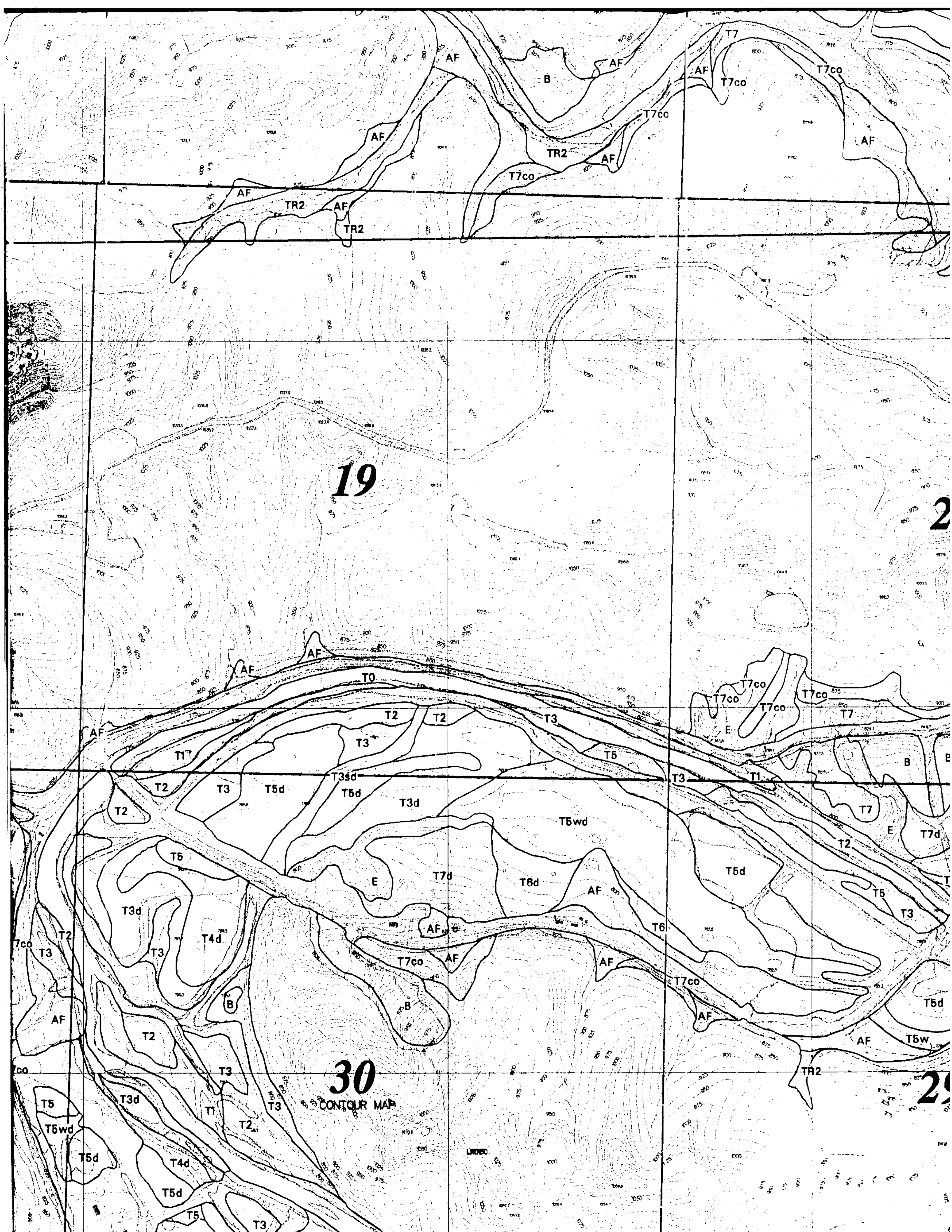

4181000
8
4180000
T2s
T1
T0
T1
T4
T7d
T2s
T3s
T3d
T1
T1
T2
T2 AF
17
TR1
T3
T2
TR1
T2d
T1
T0
4179000
T1
T2
AF
T3d
T2d
AF
T2d
AF
T3d
T7
AF
T7co
T7co
T3sd
T2
T3sd
AF

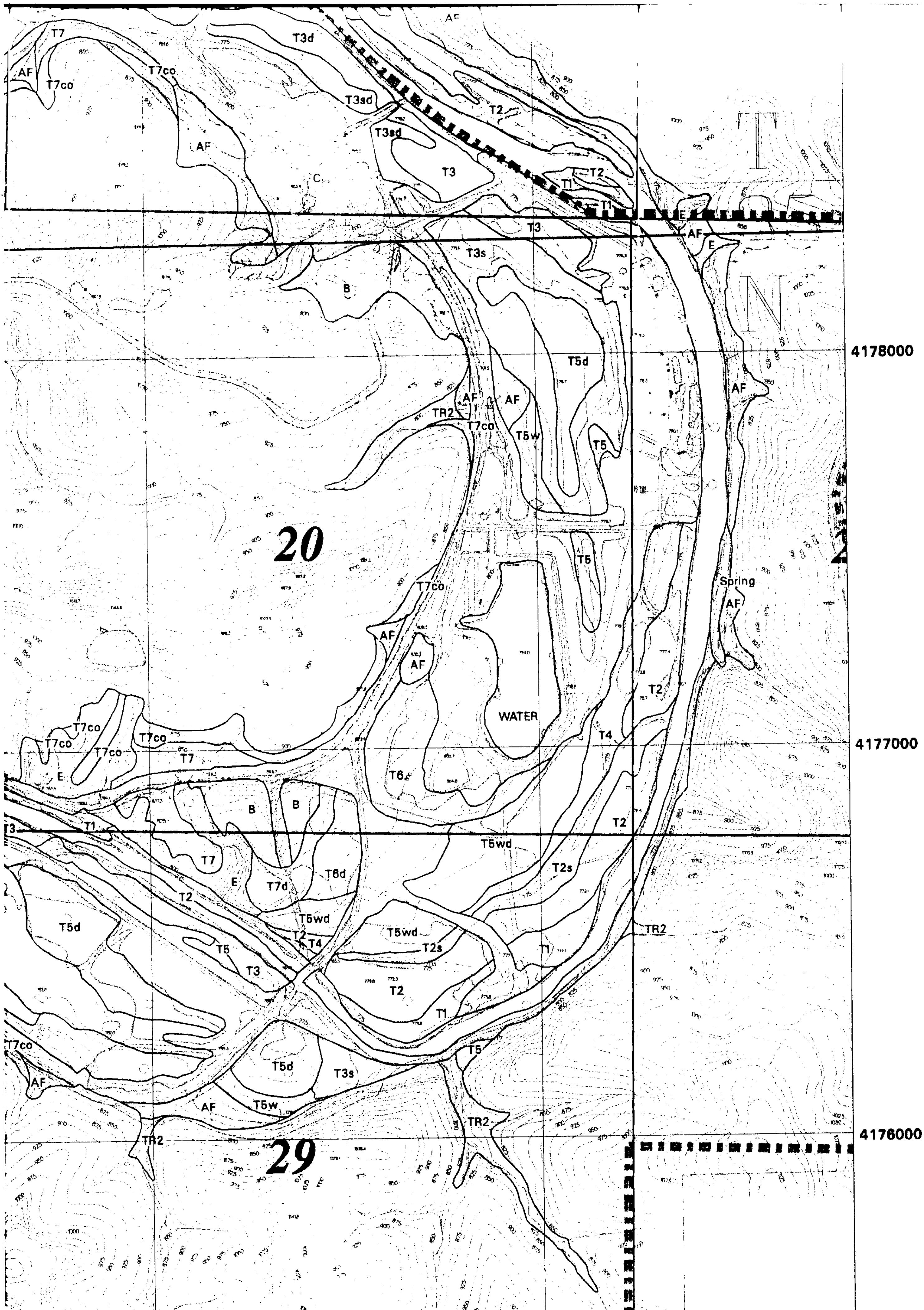


T5
T4
TR1
T1
T5
T7
AF
T5
4178000
T4
AF
22
4177000
27
4176000

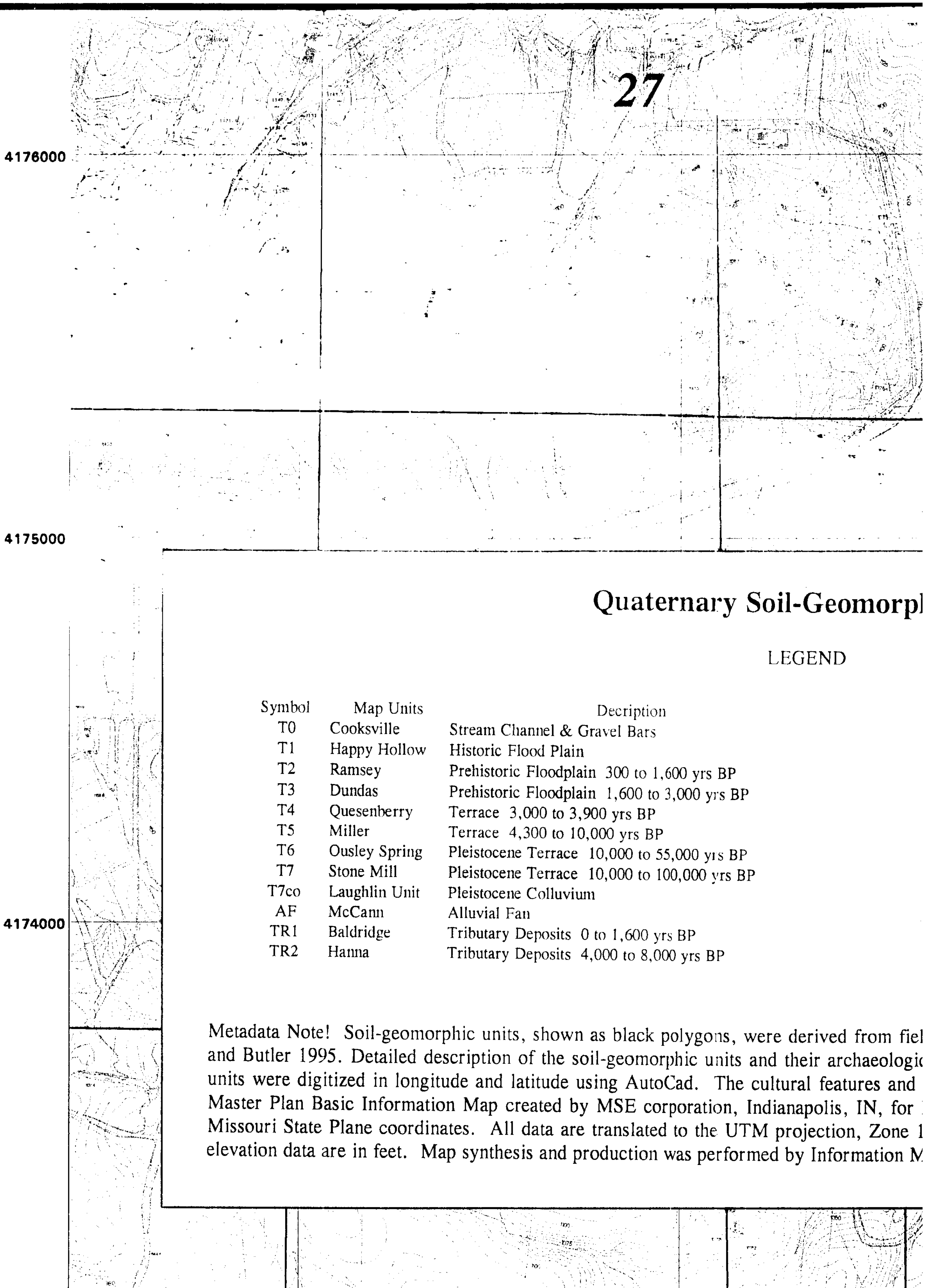

28
26
AF
TR2d
AF

AF
AF
24
AF
AF
T1
T2
T3
T5
T2
TR2
TR2d
T5
T3d
T4d
T3
AF
T7co
T2
T3
TR2d
AF
B
AF
T2
AF
AF
T7co
T3
25
T5
T3d
T1
T2
T5wd
T5d
T4d
T5d
T5
T3


19
30
CONTOUR MAP
AF
B
T7
T7co
TR2
T0
T1
T2
T3
T3d
T3sd
T4d
T5
T5d
T5wd
T5w
T6
T6d
T7d
E



T7
AF
T7co
T3d
T3sd
T3
T2
T1
C
B
T3s
T5d
TR2
T5w
T5
20
T7co
Spring
WATER
T4
T6
T7
E
T5wd
T2s
T6d
T7d
T5d
T3s
T5w
29
4178000
4177000
4176000

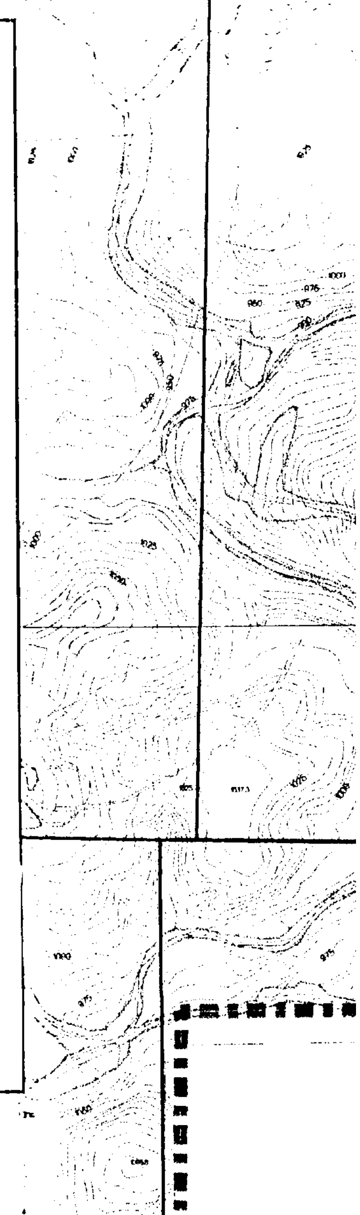


Quaternary Soil-Geomorpl

LEGEND

Symbol	Map Units	Decription
T0	Cooksville	Stream Channel & Gravel Bars
T1	Happy Hollow	Historic Flood Plain
T2	Ramsey	Prehistoric Floodplain 300 to 1,600 yrs BP
T3	Dundas	Prehistoric Floodplain 1,600 to 3,000 yrs BP
T4	Quesenberry	Terrace 3,000 to 3,900 yrs BP
T5	Miller	Terrace 4,300 to 10,000 yrs BP
T6	Ousley Spring	Pleistocene Terrace 10,000 to 55,000 yrs BP
T7	Stone Mill	Pleistocene Terrace 10,000 to 100,000 yrs BP
T7co	Laughlin Unit	Pleistocene Colluvium
AF	McCann	Alluvial Fan
TR1	Baldridge	Tributary Deposits 0 to 1,600 yrs BP
TR2	Hanna	Tributary Deposits 4,000 to 8,000 yrs BP

Metadata Note! Soil-geomorphic units, shown as black polygons, were derived from fiel
and Butler 1995. Detailed description of the soil-geomorphic units and their archaeologic
units were digitized in longitude and latitude using AutoCad. The cultural features and
Master Plan Basic Information Map created by MSE corporation, Indianapolis, IN, for
Missouri State Plane coordinates. All data are translated to the UTM projection, Zone 1
elevation data are in feet. Map synthesis and production was performed by Information M



rnary Soil-Geomorphic Map

LEGEND

00 yrs BP
,000 yrs BP
,000 yrs BP
),000 yrs BP
BP
)yrs BP

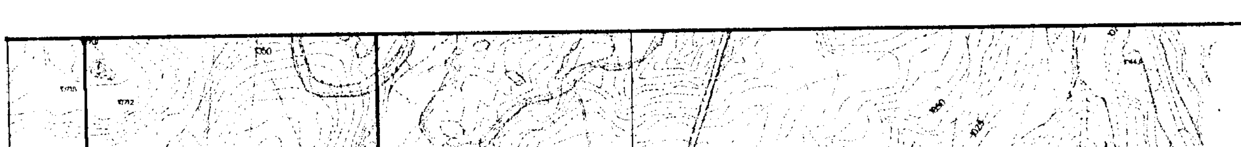
Subscripts

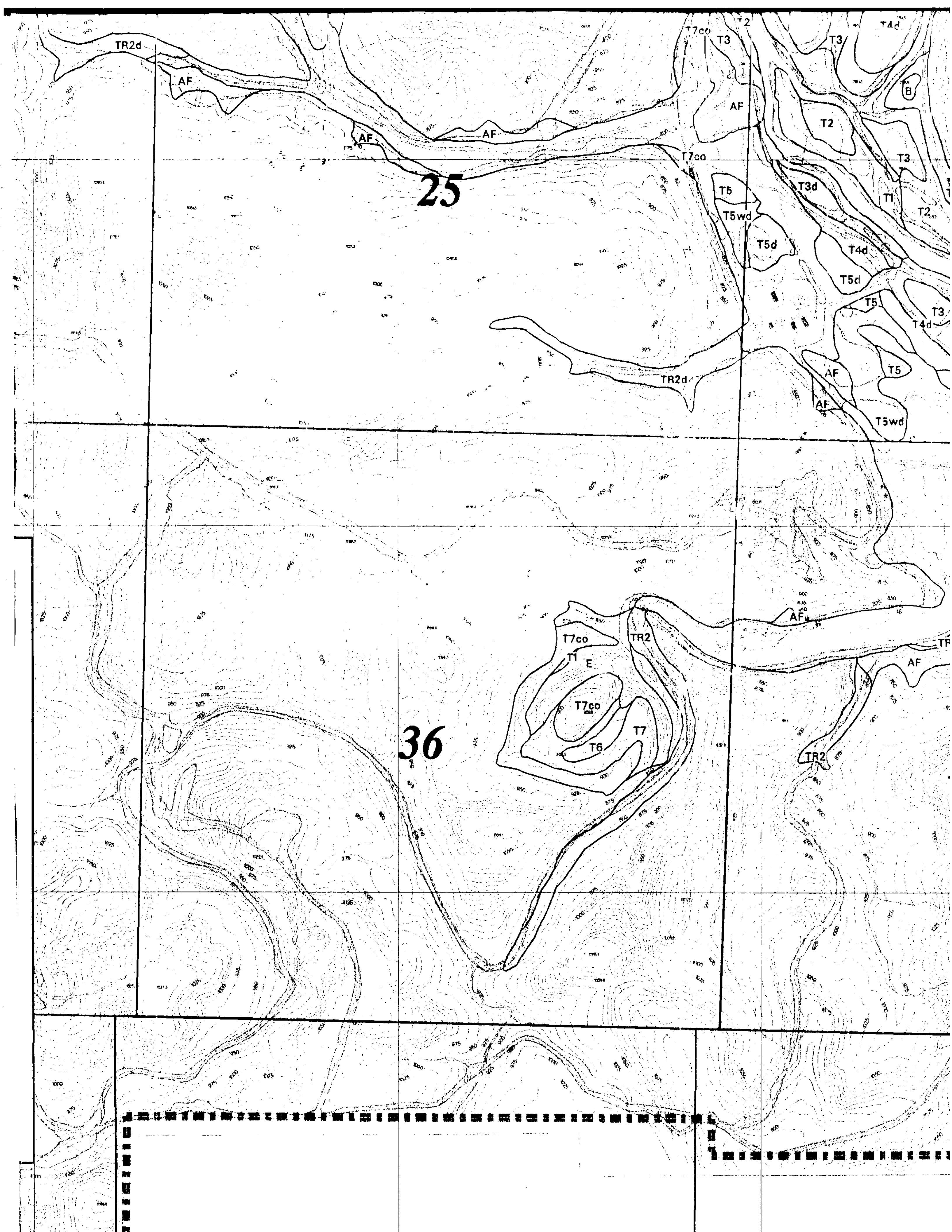
Letter	Soil Property
c	Clayey Soil
o	Dark Surface
r	>35% Gravel
s	Slough
w	Wet Soil
d	Disturbed

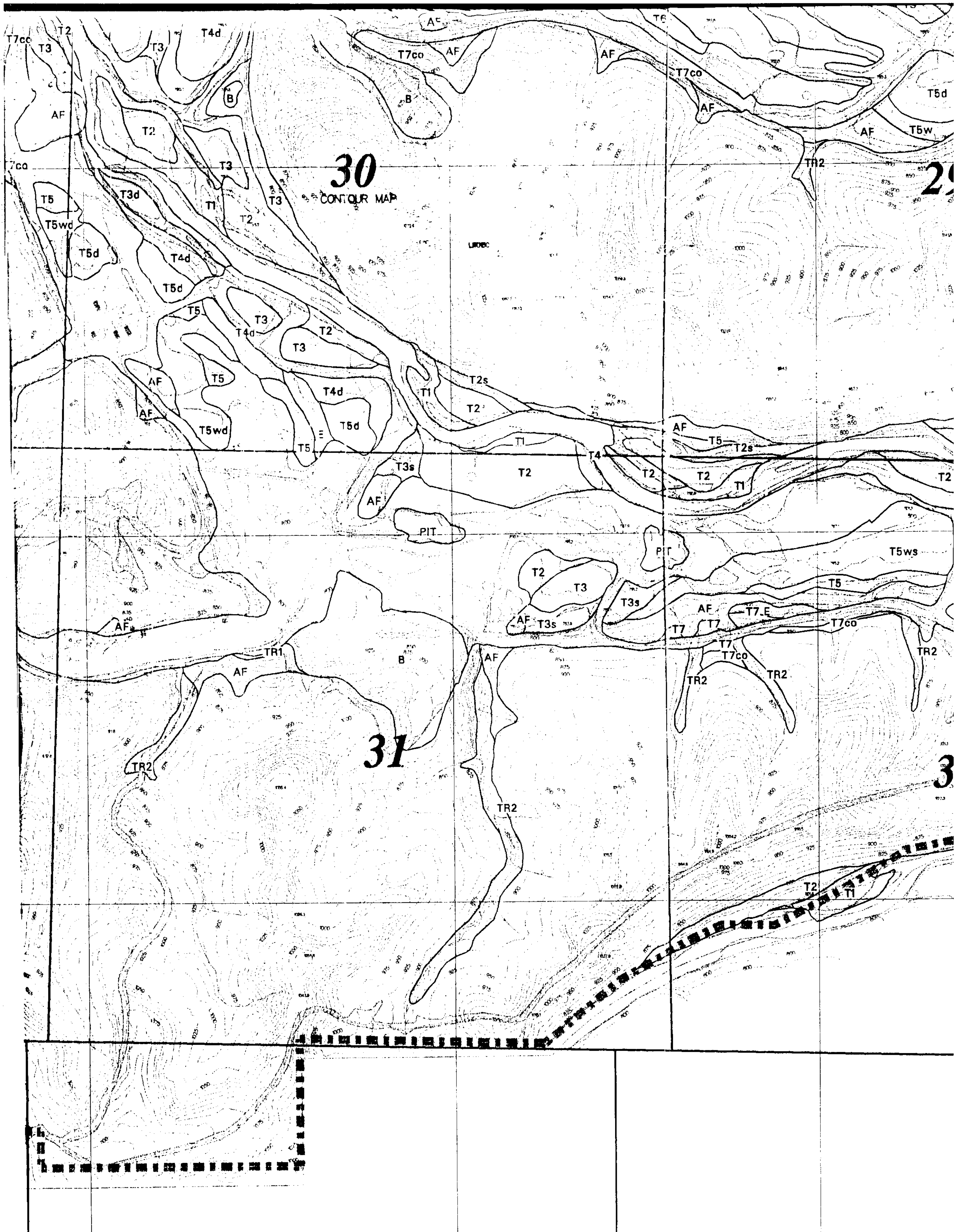
Miscellaneous Units

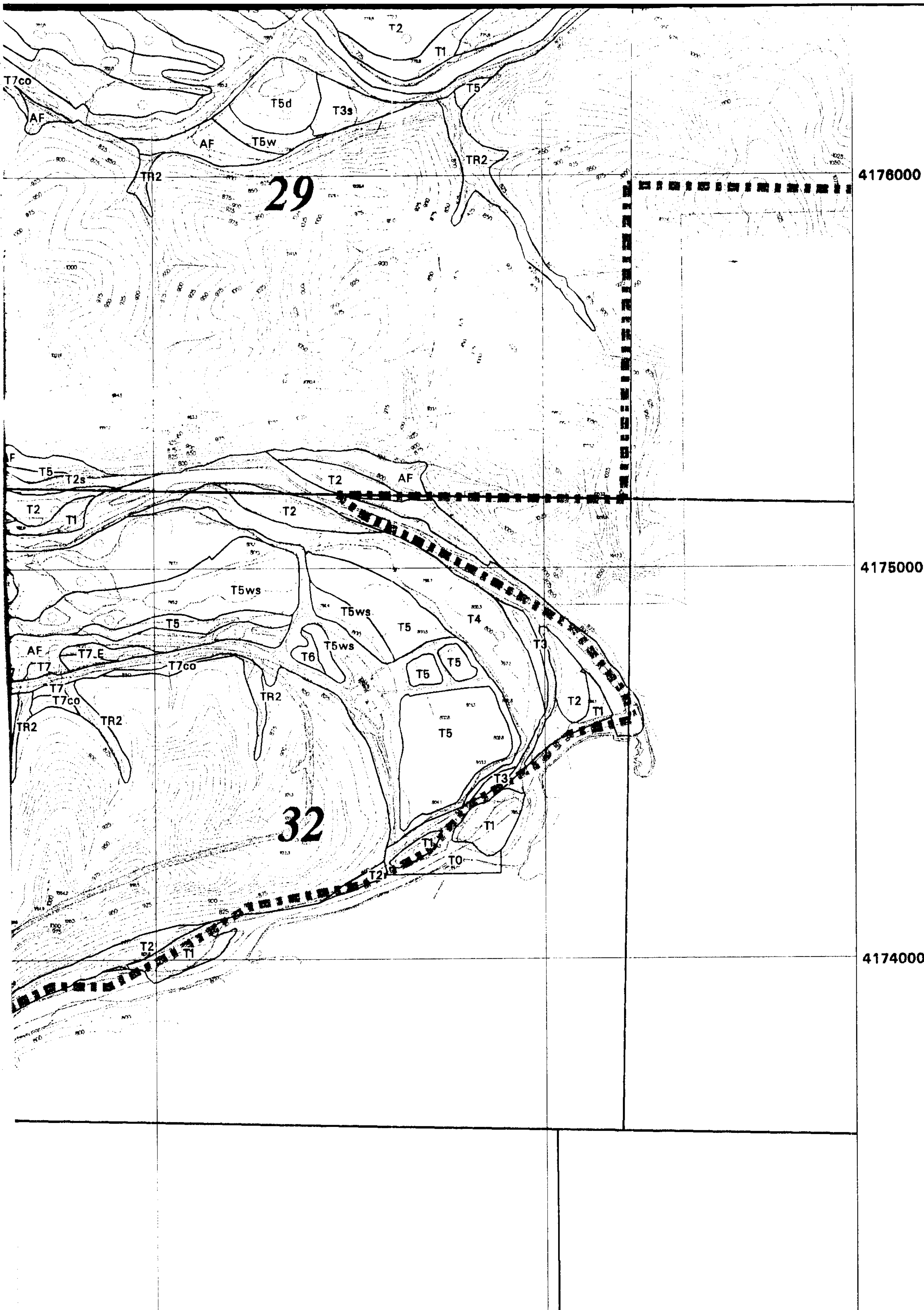
B	Borrow area
C	Construction
CO	Colluvial wedge area
E	Escarpment W/O bedrock

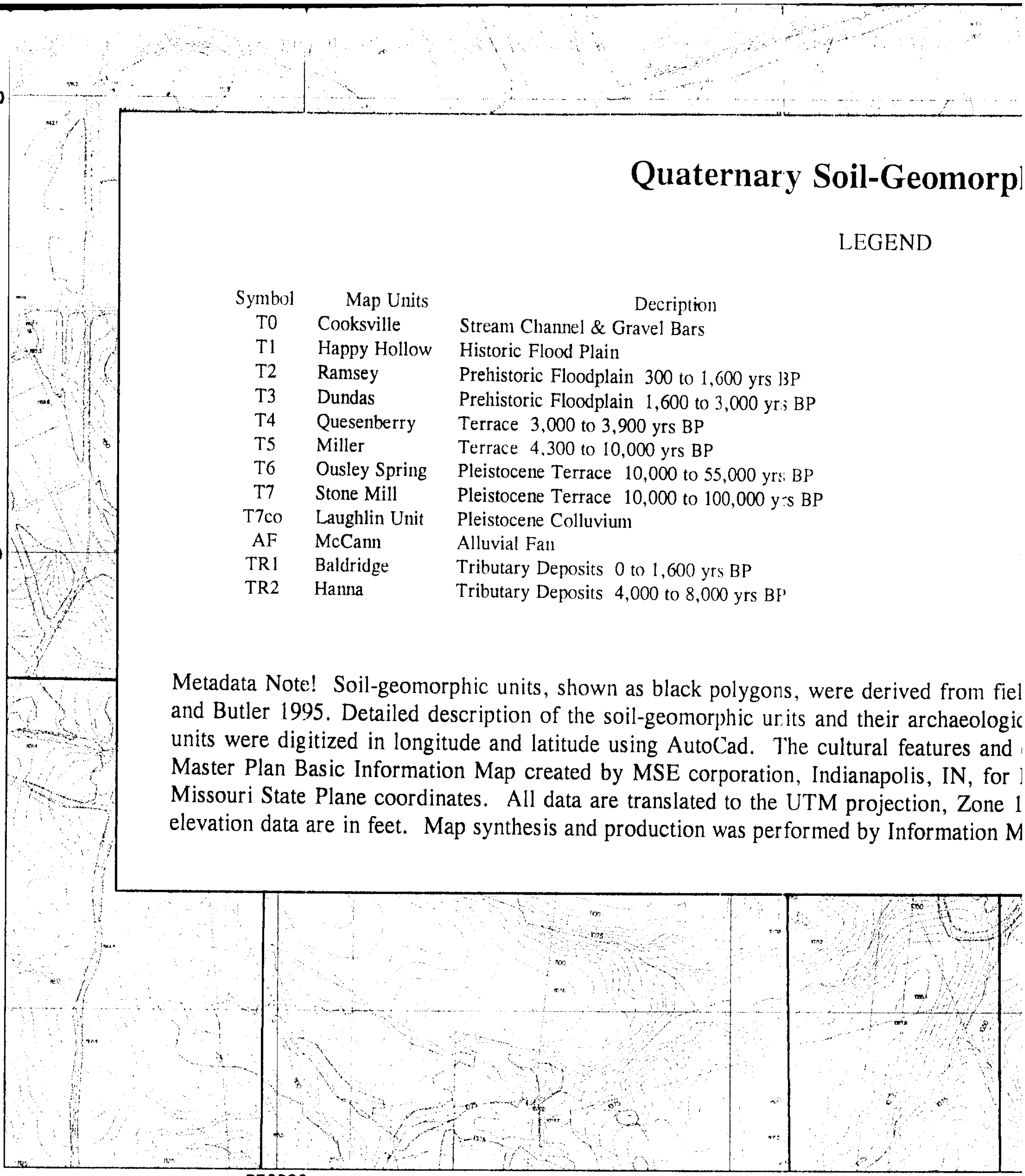
lygons, were derived from field mapping conducted during this study, Albertson,Meinert, hic units and their archaeological potential are contained in the text. The soil-geomorphic ad. The cultural features and contours, shown as half-tones, were derived from the 1992 oration, Indianapolis, IN, for Fort Leonard Wood in Intergraph Design File format using o the UTM projection, Zone 15 using Arcinfo. The UTM grid is in meters. The contour as performed by Information Management Systems, Inc.,Vicksburg, MS in August 1995.




TR2d
AF
AF
AF
25
T7co
T3
T2
T4d
T3
B
AF
T2
T7co
T3
T5
T3d
T1
T5wd
T2
T5d
T4d
T5d
T5
T3
T4d
TR2d
AF
T5
AF
T5wd
AF
T7co
TR2
T1
E
T7co
T7
T6
36
AF
TR2


30
CONTOUR MAP
31
T7co
T2
T3
T4d
AF
T6
B
T5d
T5w
TR2
T3d
T1
T5
T5wd
T2s
T4
T3s
PIT
T5ws
T7
T7 E
TR1
E


4176000
4175000
4174000
29
32
T7co
AF
T5d
T3s
T5w
T2
T1
T5
TR2
T2s
T5ws
T6
T4
T3
T7.E
T7
T0



Quaternary Soil-Geomorpl

LEGEND

Symbol	Map Units	Decription
T0	Cooksville	Stream Channel & Gravel Bars
T1	Happy Hollow	Historic Flood Plain
T2	Ramsey	Prehistoric Floodplain 300 to 1,600 yrs BP
T3	Dundas	Prehistoric Floodplain 1,600 to 3,000 yrs BP
T4	Quesenberry	Terrace 3,000 to 3,900 yrs BP
T5	Miller	Terrace 4,300 to 10,000 yrs BP
T6	Ousley Spring	Pleistocene Terrace 10,000 to 55,000 yrs BP
T7	Stone Mill	Pleistocene Terrace 10,000 to 100,000 yrs BP
T7co	Laughlin Unit	Pleistocene Colluvium
AF	McCann	Alluvial Fan
TR1	Baldridge	Tributary Deposits 0 to 1,600 yrs BP
TR2	Hanna	Tributary Deposits 4,000 to 8,000 yrs BP

Metadata Note! Soil-geomorphic units, shown as black polygons, were derived from fiel and Butler 1995. Detailed description of the soil-geomorphic units and their archaeologic units were digitized in longitude and latitude using AutoCad. The cultural features and Master Plan Basic Information Map created by MSE corporation, Indianapolis, IN, for Missouri State Plane coordinates. All data are translated to the UTM projection, Zone 1 elevation data are in feet. Map synthesis and production was performed by Information M

rnary Soil-Geomorphic Map

LEGEND

00 yrs BP
,000 yrs BP

,000 yrs BP
0,000 yrs BP

BP
0 yrs BP

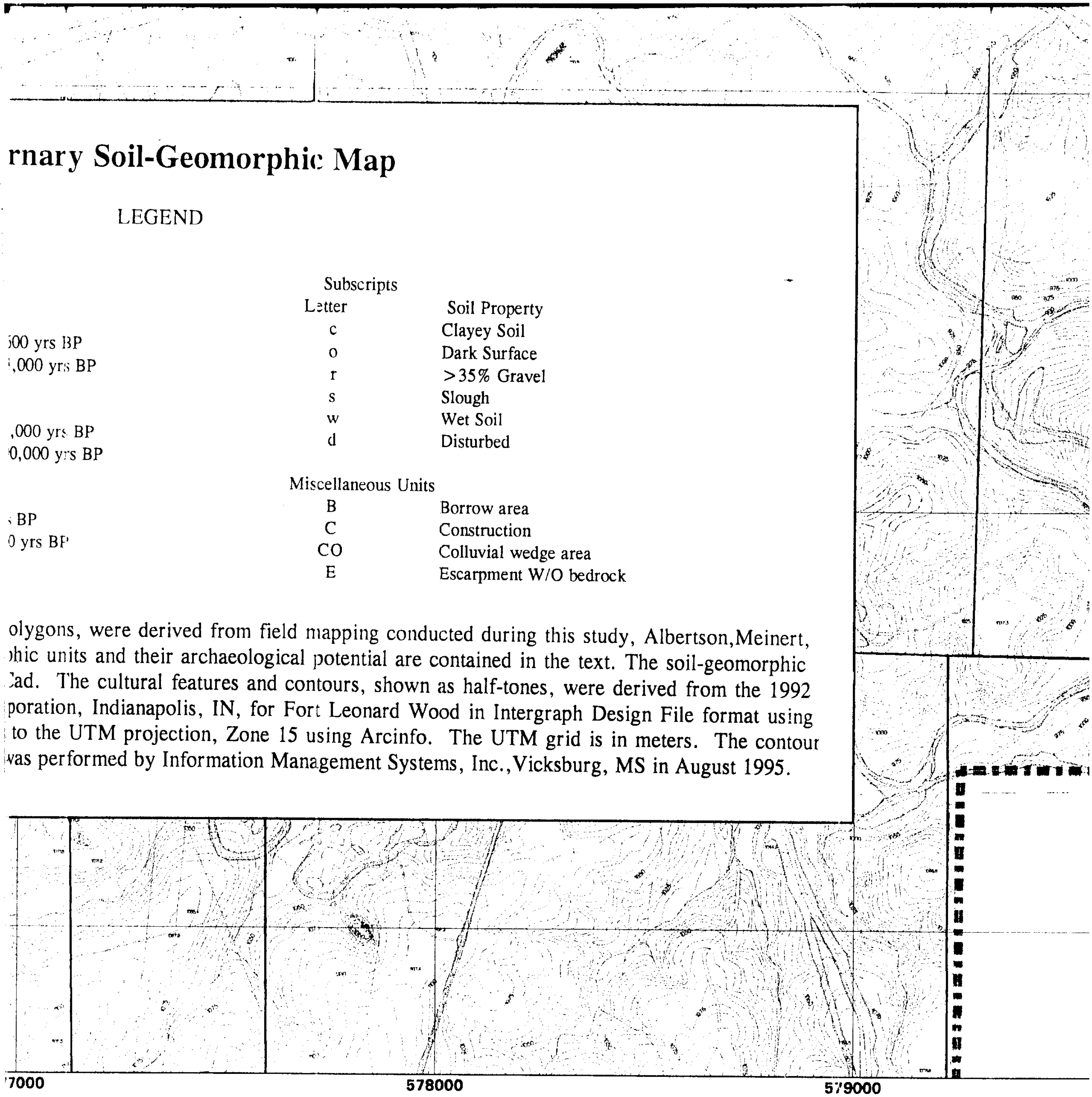
Subscripts

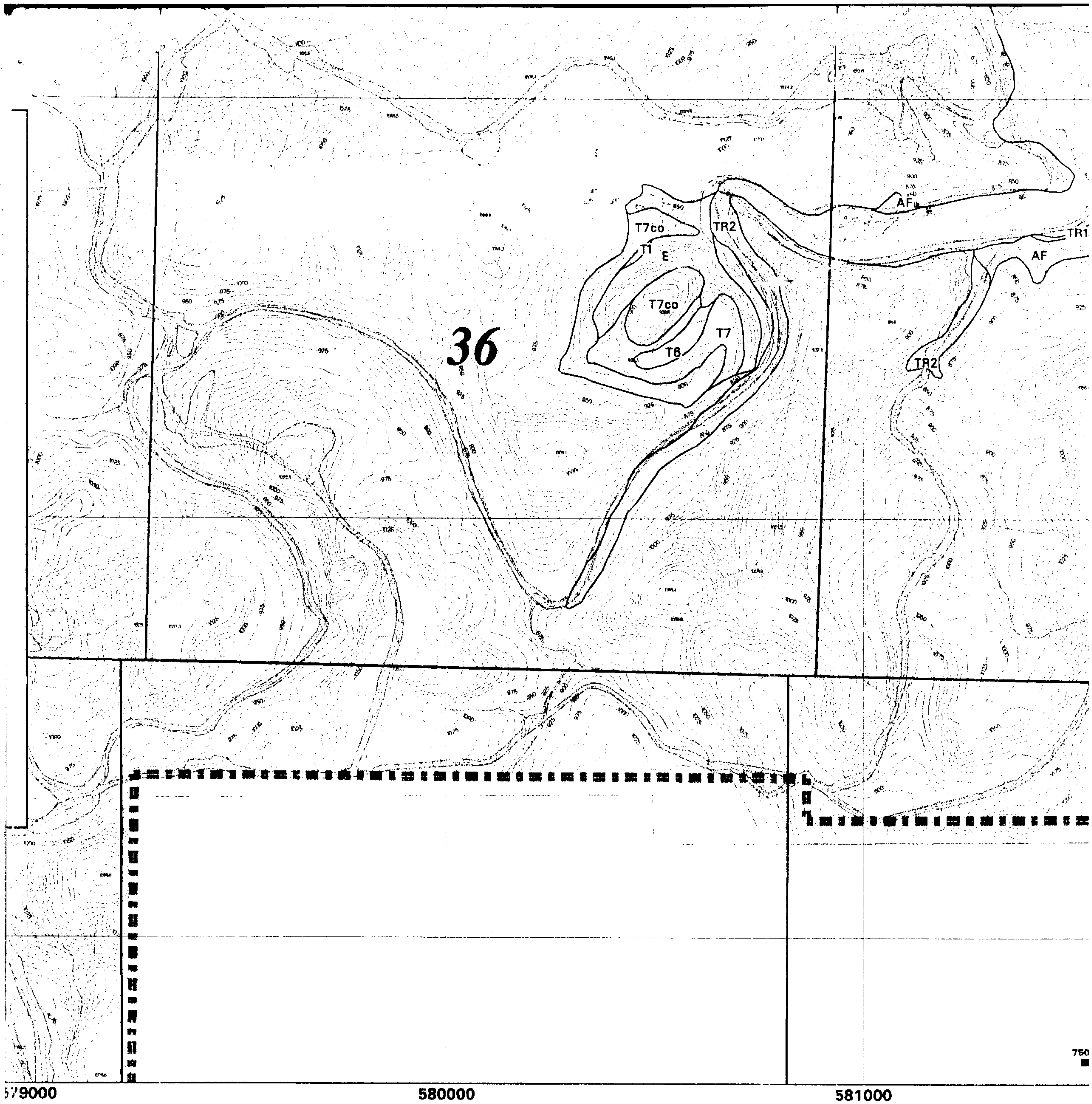
Letter	Soil Property
c	Clayey Soil
o	Dark Surface
r	>35% Gravel
s	Slough
w	Wet Soil
d	Disturbed

Miscellaneous Units

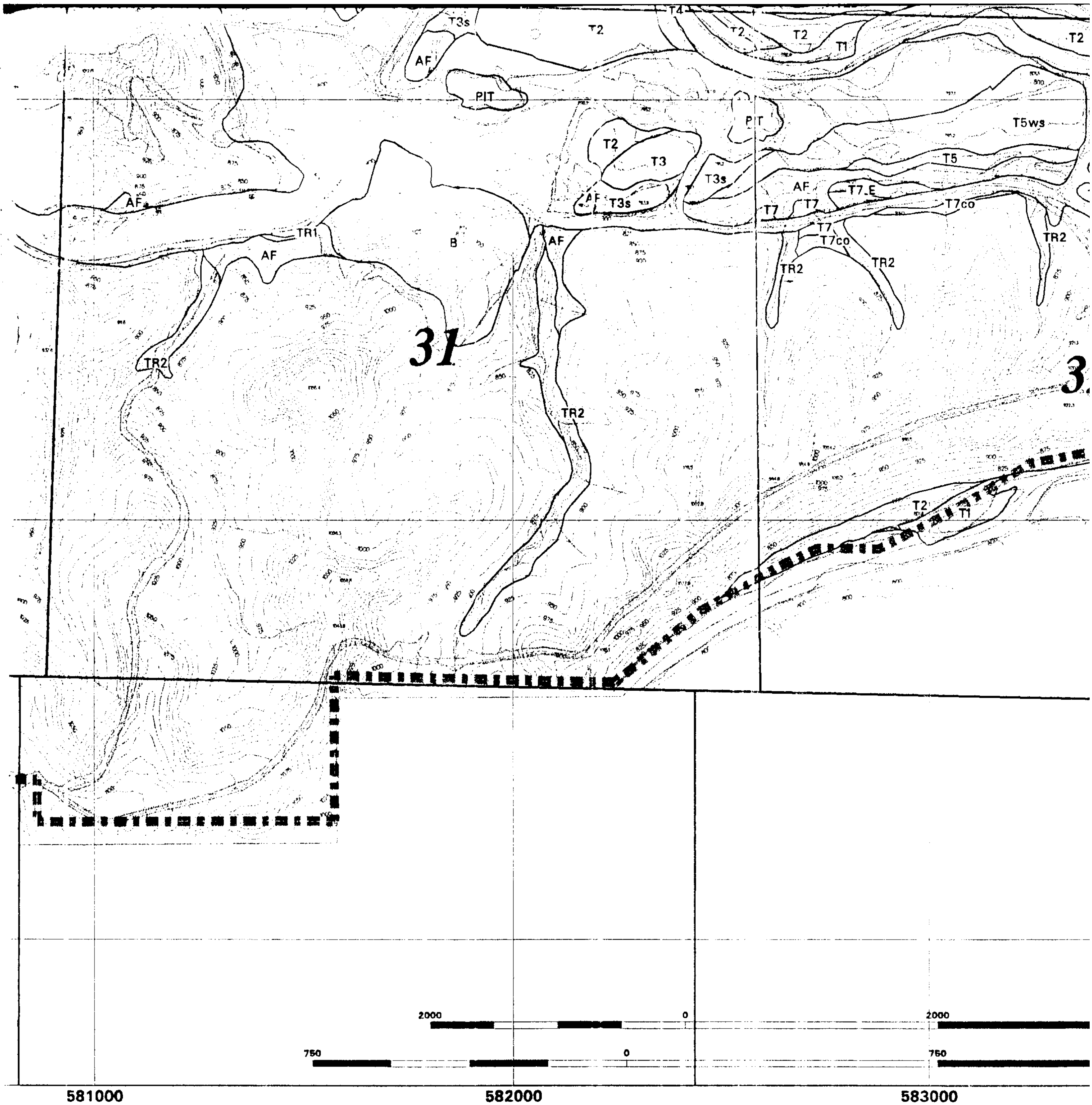
B	Borrow area
C	Construction
CO	Colluvial wedge area
E	Escarpment W/O bedrock

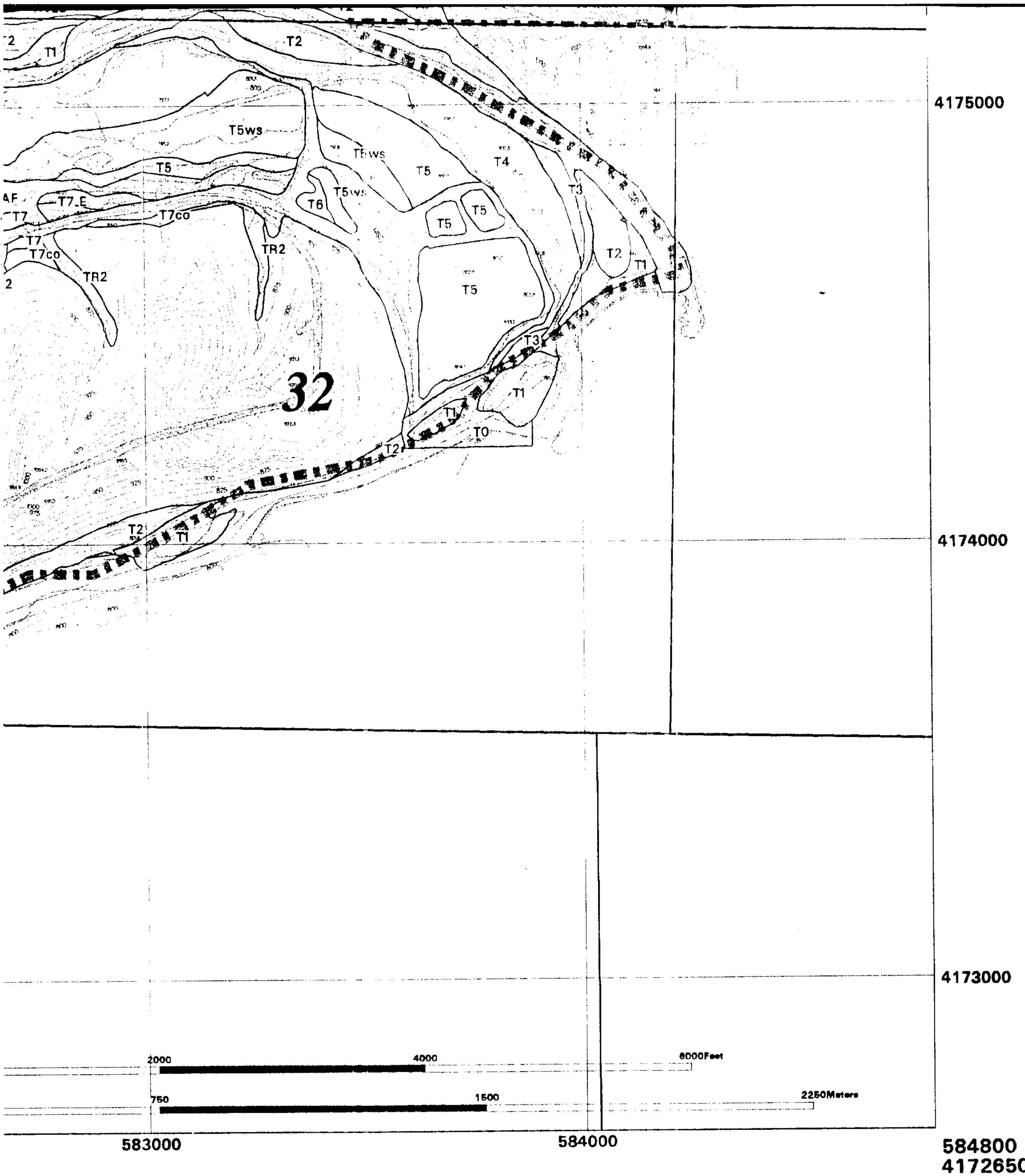
olygons, were derived from field mapping conducted during this study, Albertson,Meinert, hic units and their archaeological potential are contained in the text. The soil-geomorphic ad. The cultural features and contours, shown as half-tones, were derived from the 1992 poration, Indianapolis, IN, for Fort Leonard Wood in Intergraph Design File format using to the UTM projection, Zone 15 using Arcinfo. The UTM grid is in meters. The contour vas performed by Information Management Systems, Inc.,Vicksburg, MS in August 1995.



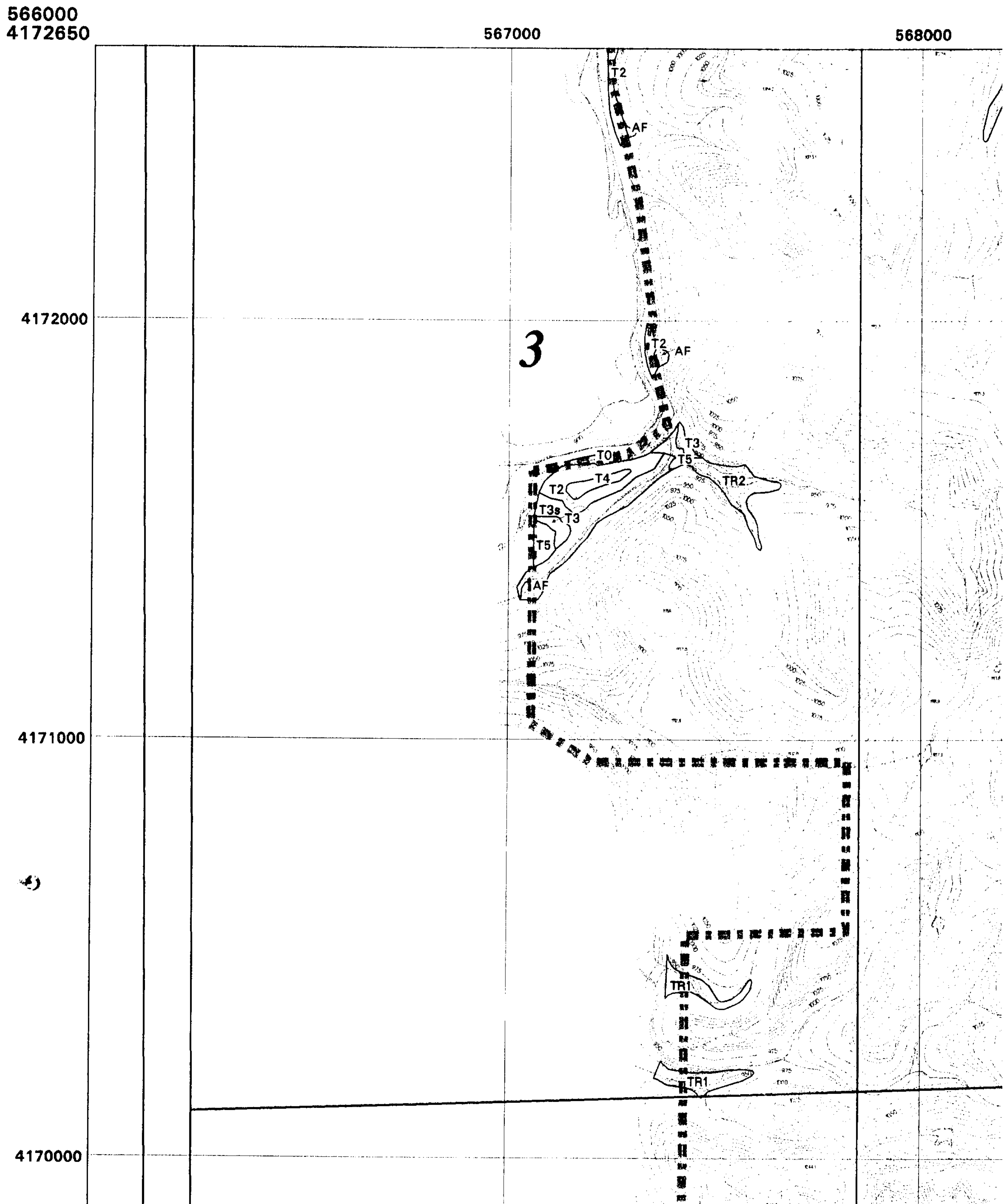


36
T7co
TR2
T1
E
T7co
T7
T6
AF
TR1
AF
TR2
579000
580000
581000

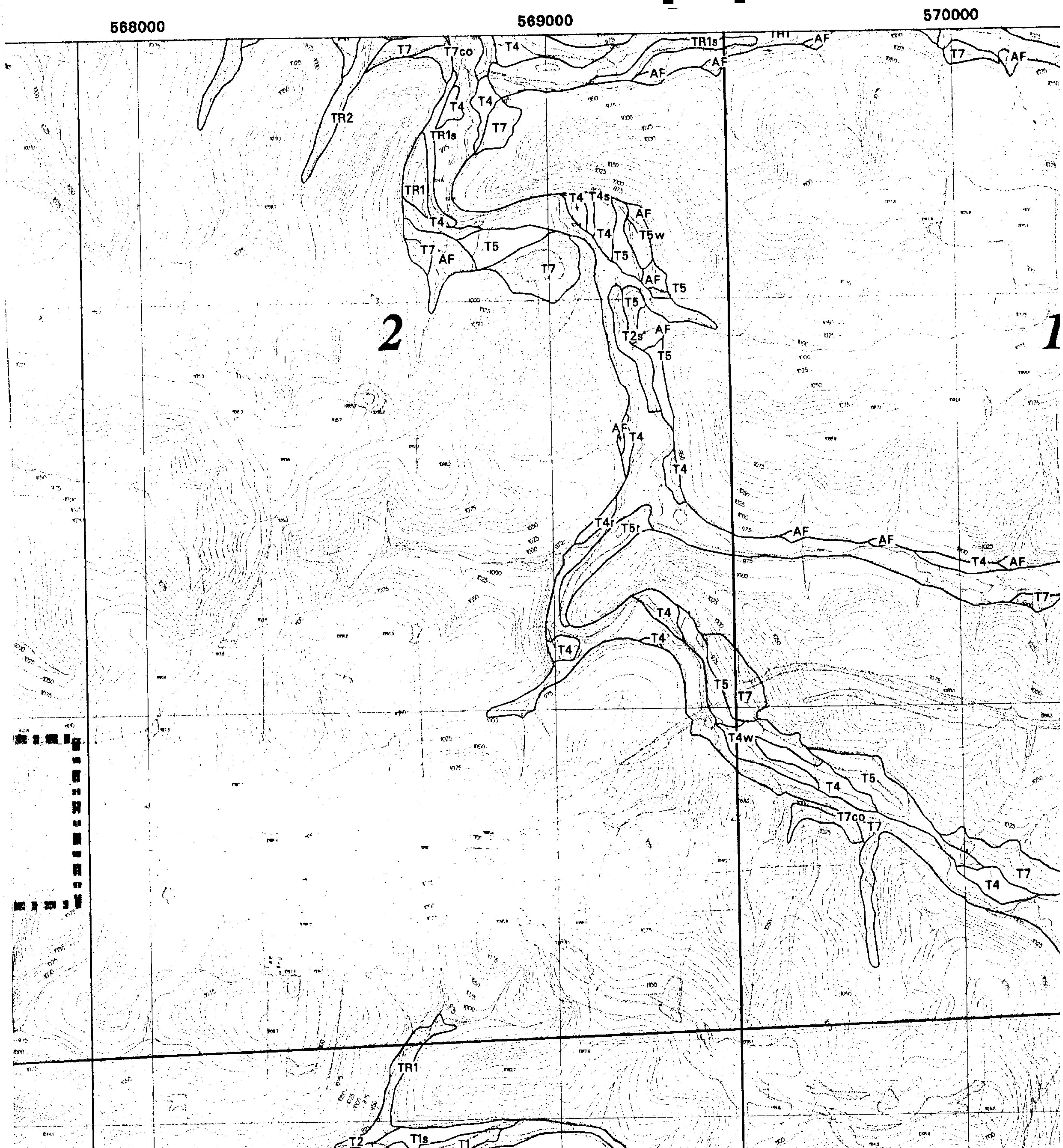

T3s
T2
T4
T2
T2
T1
T2
AF
PIT
PIT
T5ws
T2
T3
T3s
T5
AF
T3s
AF
T7
T7
T7-E
T7co
T7
T7co
AF
TR1
AF
B
AF
TR2
TR2
TR2
31
TR2
TR2
T2
T1
2000
0
2000
750
0
750
581000
582000
583000



T2
T1
T2
T5ws
T5ws
T5
T4
T5
T3
T5ws
T6
T5
T5
AF
T7.E
T7
T7co
T7
T7co
TR2
TR2
T2
T1
T5
T3
32
T1
T1
T0
T2
T2
T1
4175000
4174000
4173000
2000
4000
6000Feet
750
1500
2250Meters
583000
584000
584800
4172650

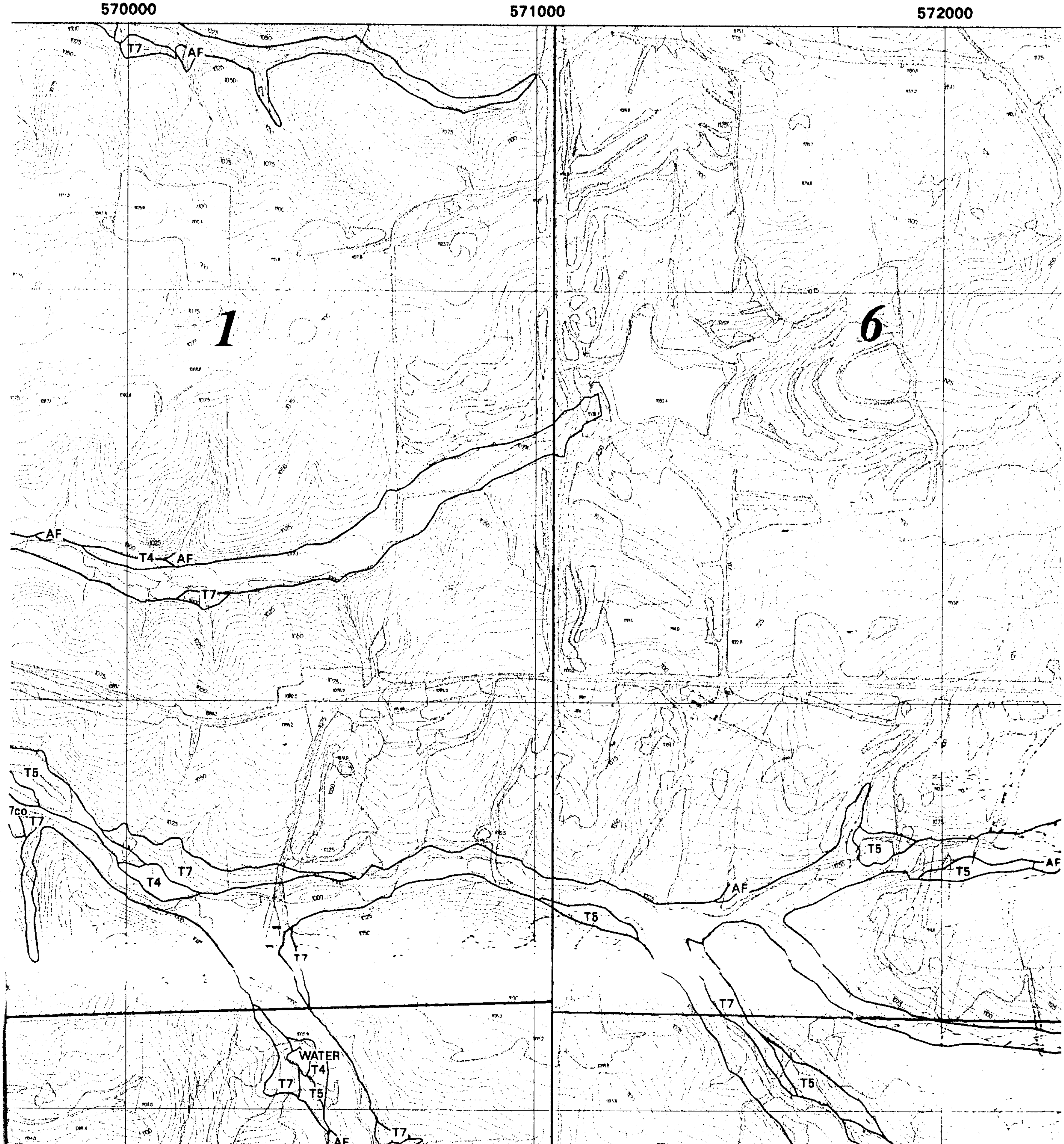

566000
4172650
567000
568000
4172000
4171000
4170000
3
T2
AF
T2
AF
T0
T3
T5
T4
T2
TR2
T3s
T3
T5
AF
TR1
TR1

Upper R

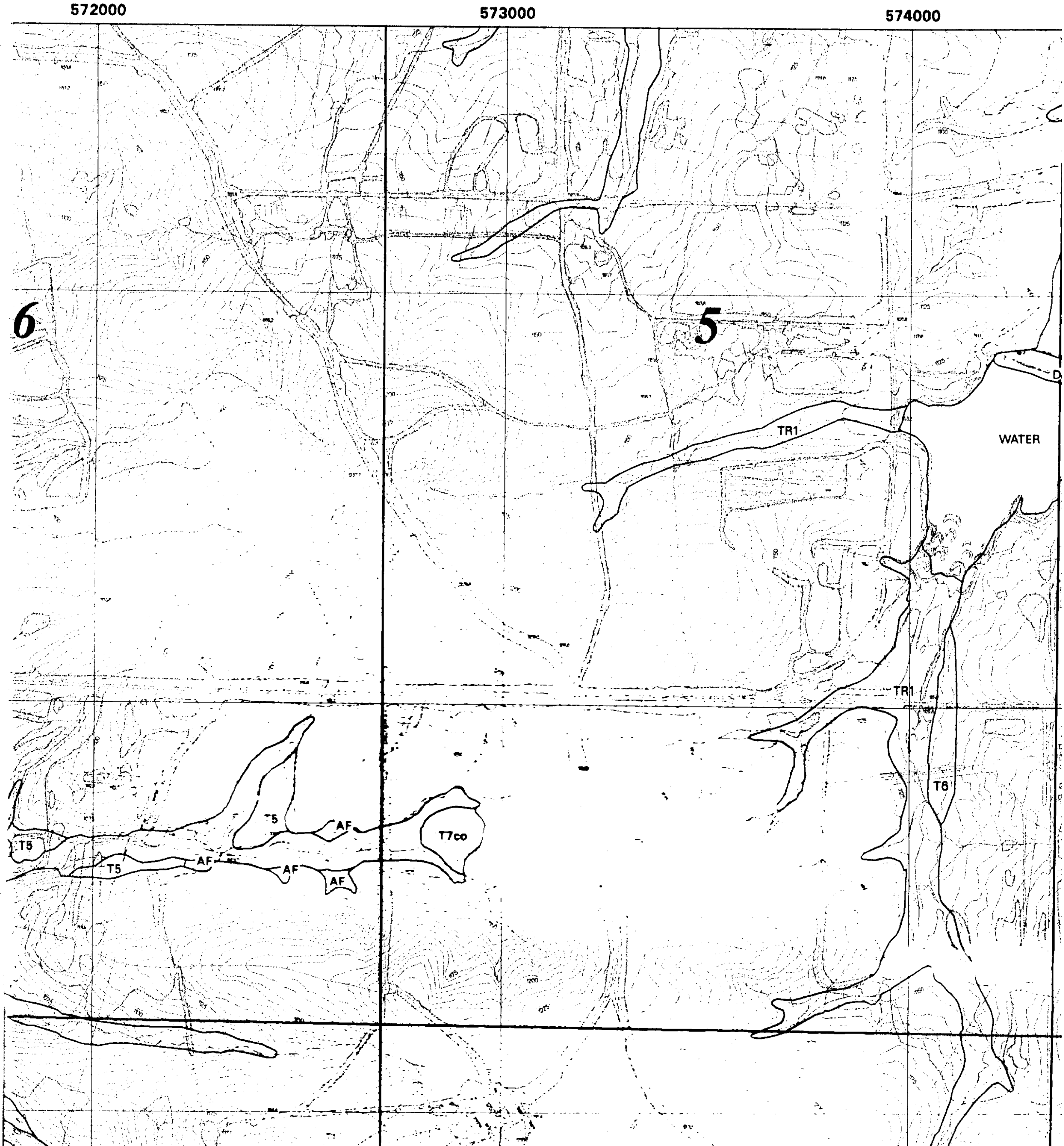


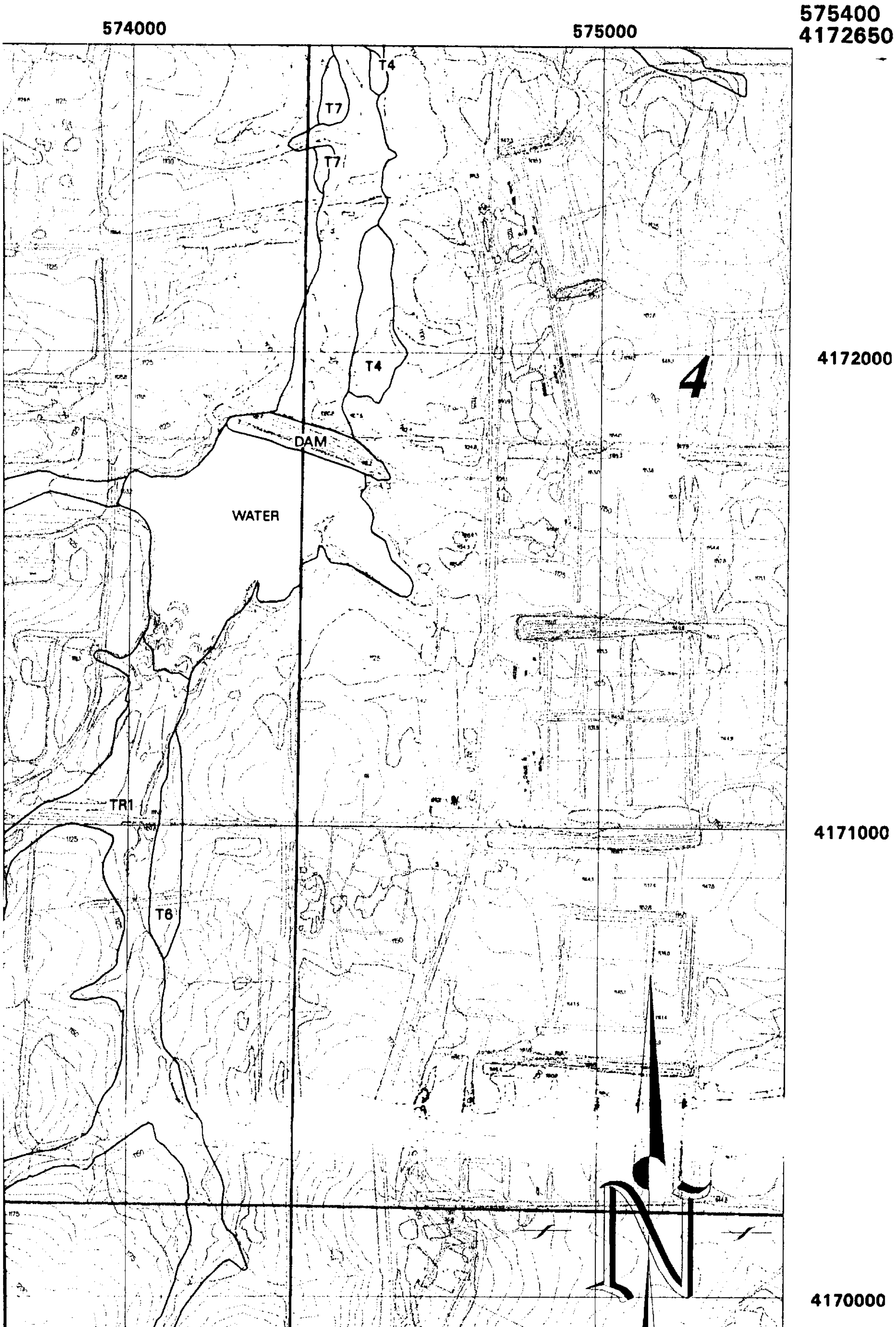
568000
569000
570000
2
TR2
T7
T7co
T4
TR1s
TR1
AF
T5
T5w
T4s
T2s
T4r
T5r
T4w
T7co
T1s
T2
T1

er Roubidoux Cree

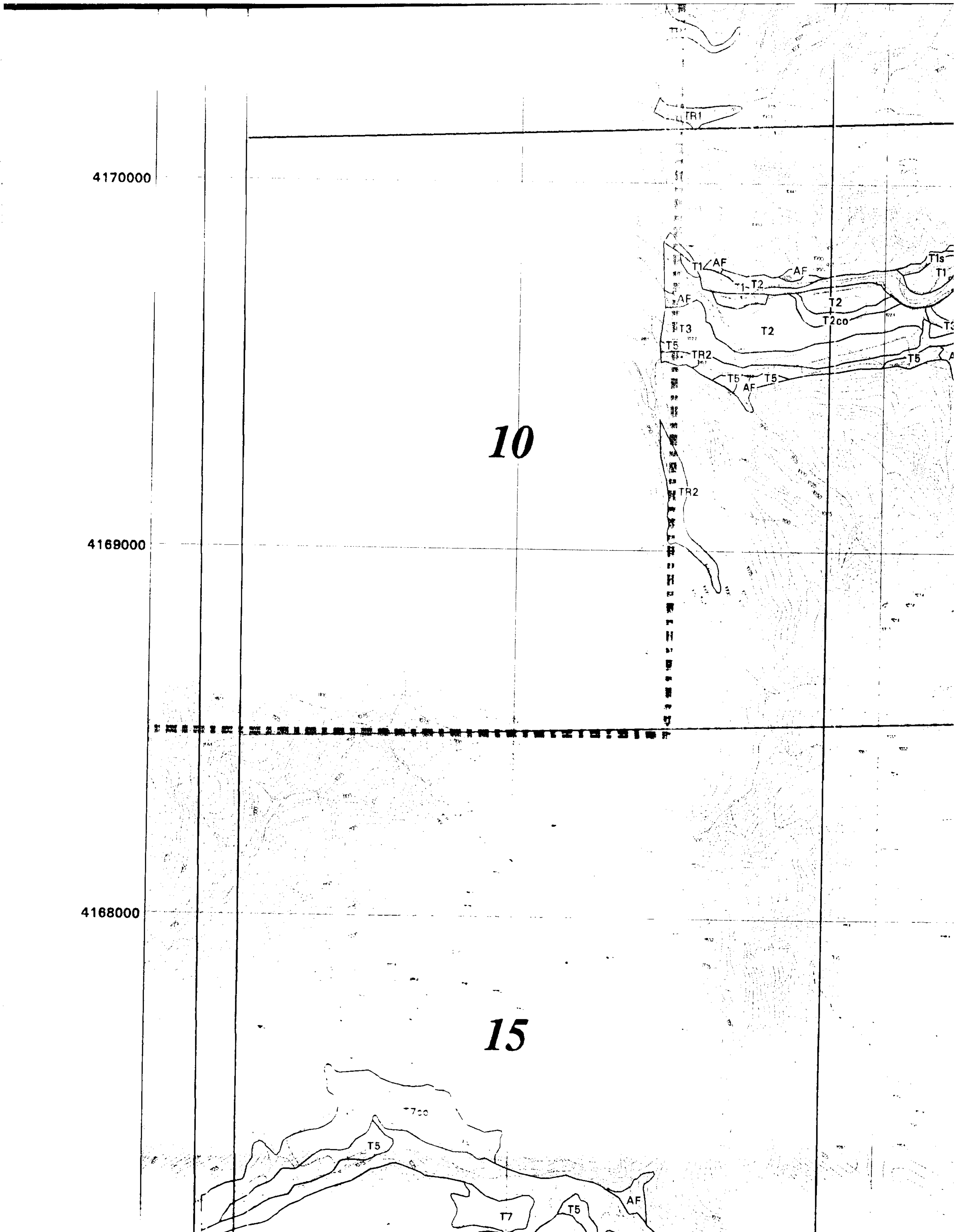


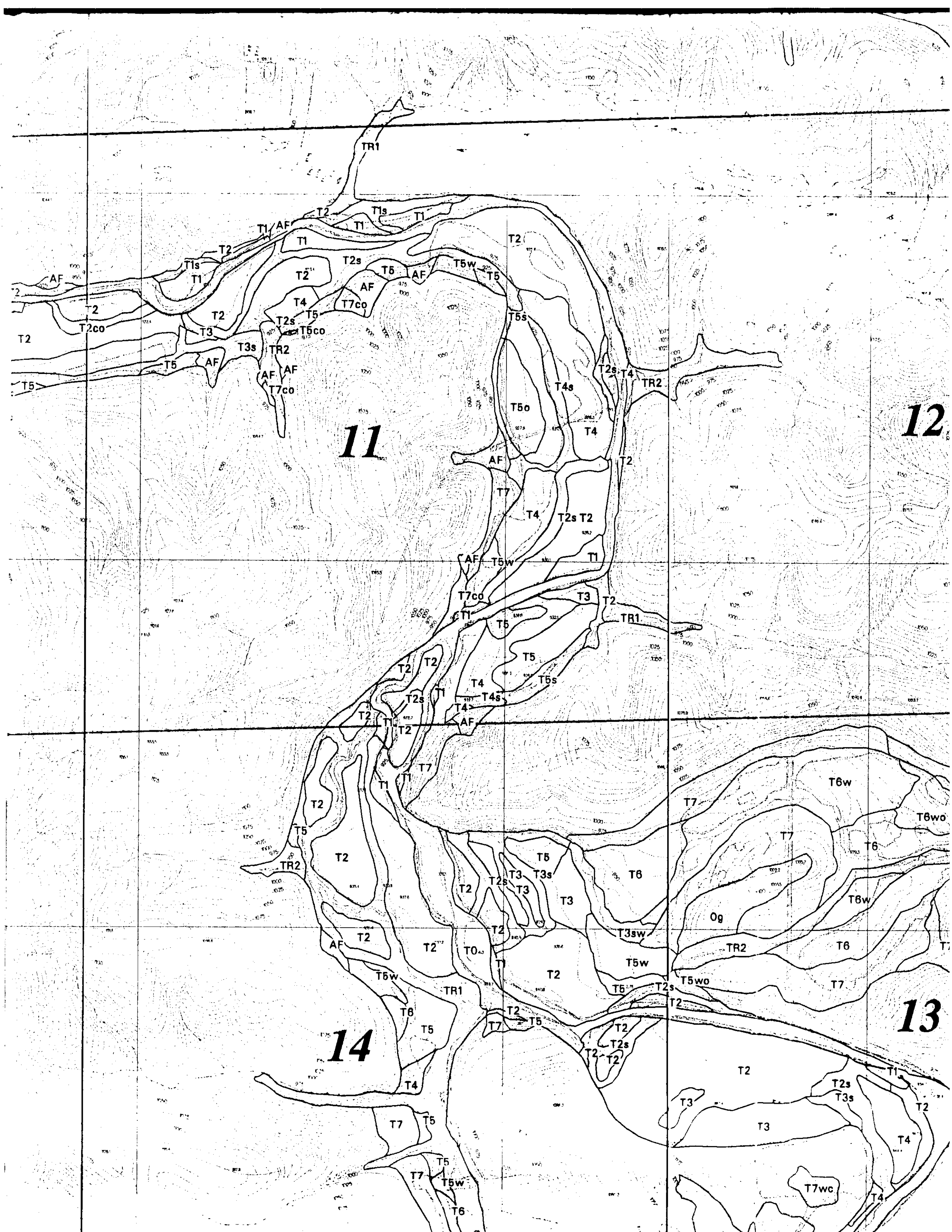
Creek


572000
573000
574000
6
5
TR1
WATER
TR1
T6
T5
T5
AF
T7co
T5
AF
AF
AF

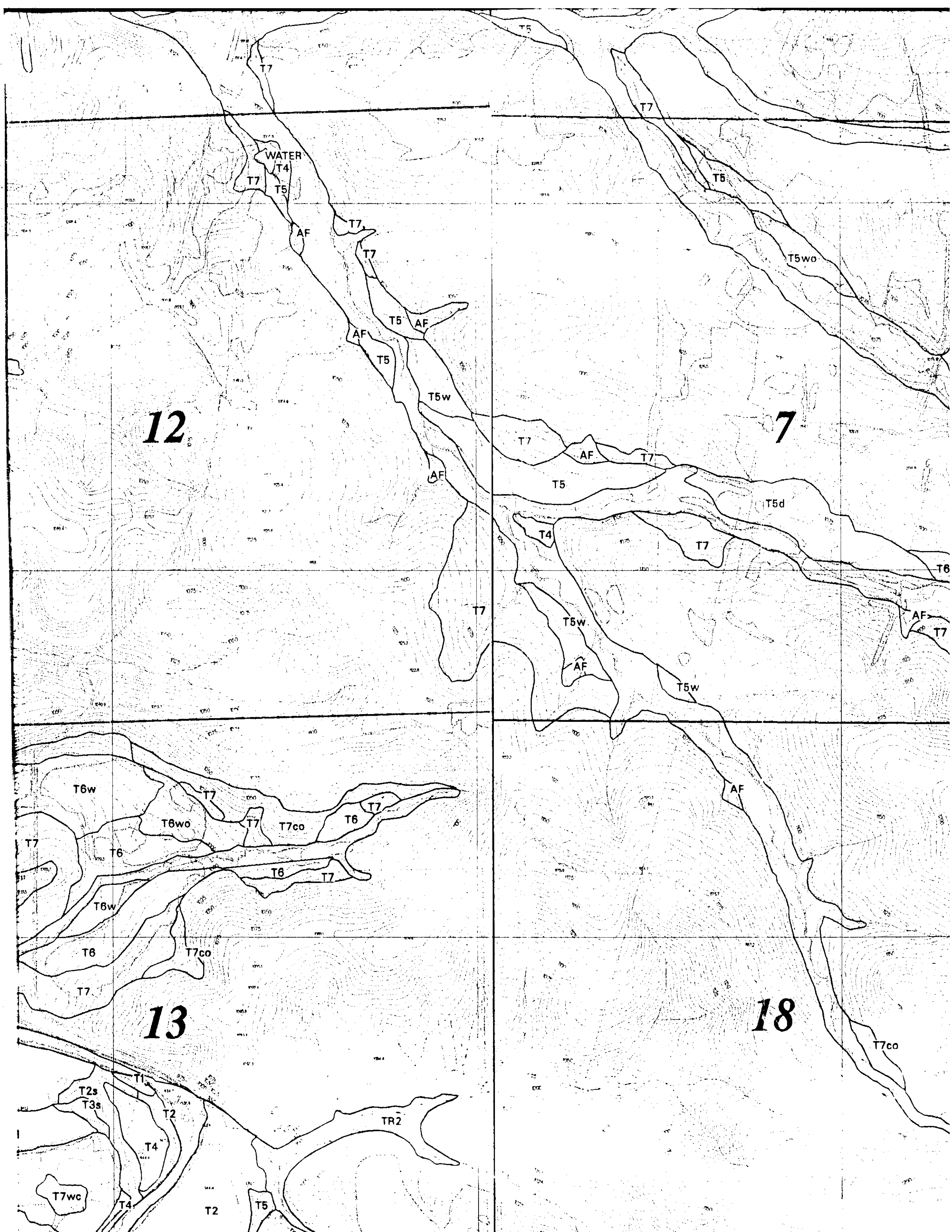


574000
575000
575400
4172650
4172000
4171000
4170000
T4
T7
T7
T4
DAM
WATER
TR1
T6
4

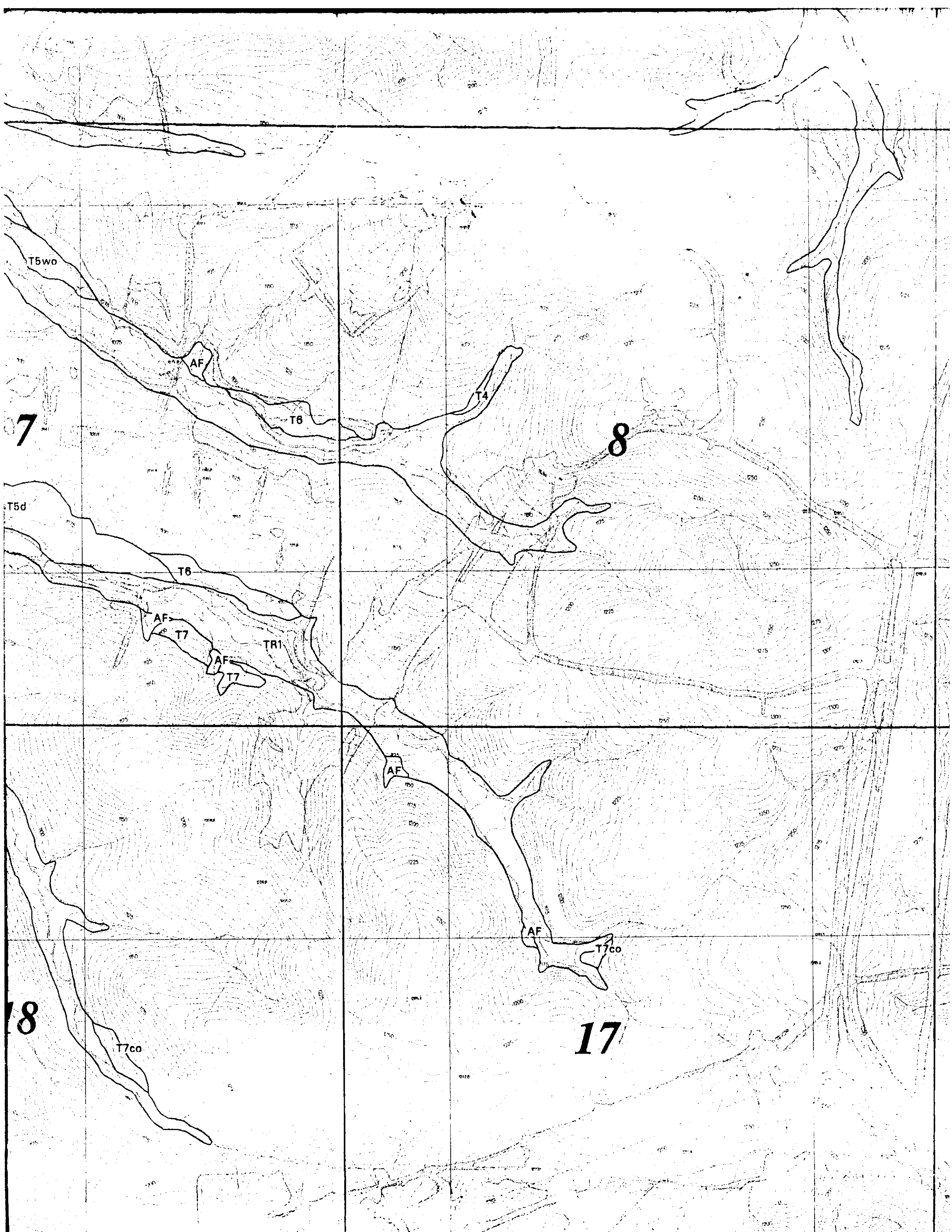

4170000
4169000
4168000
10
15
TR1
T1
AF
T2
T2co
T3
T5
TR2
T1s
T7co
T7

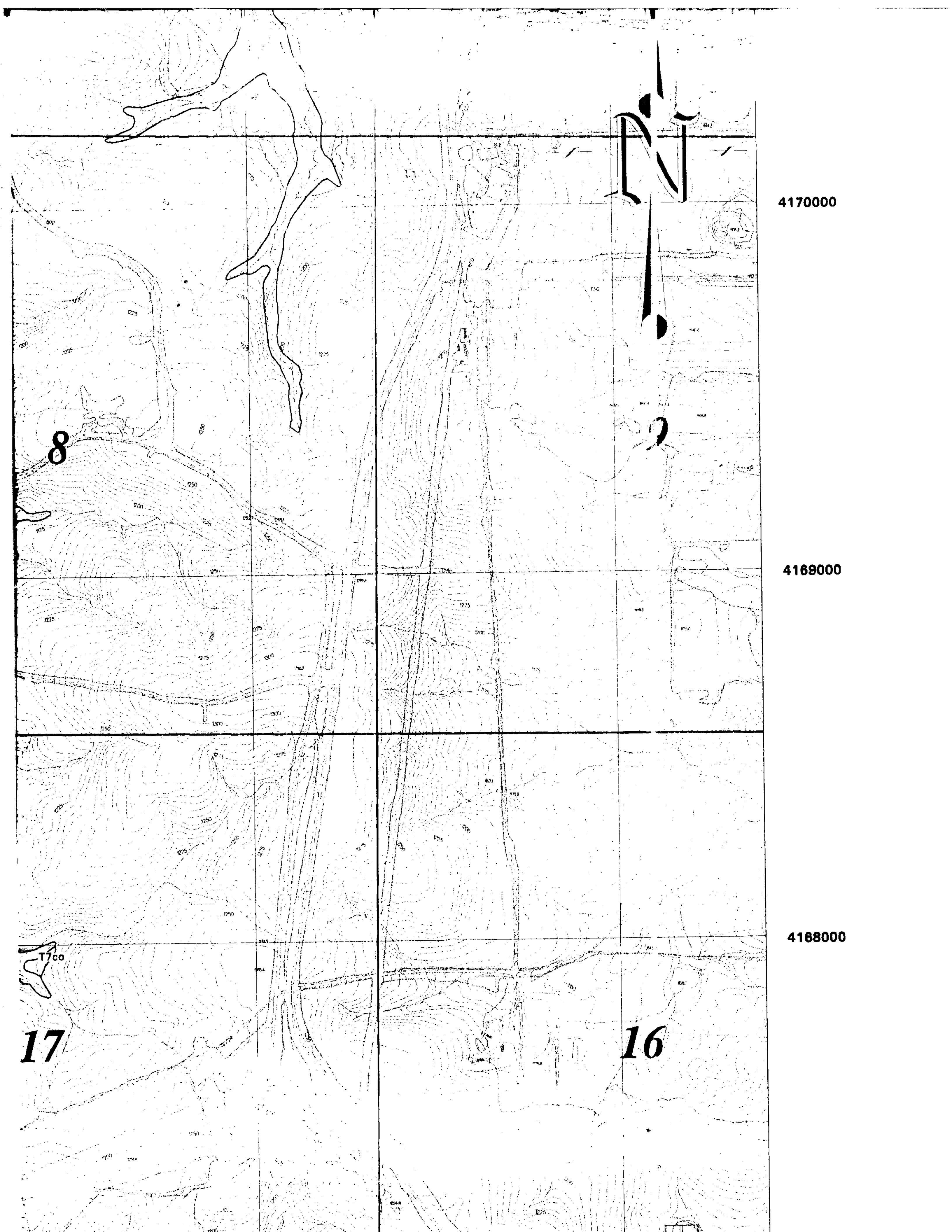


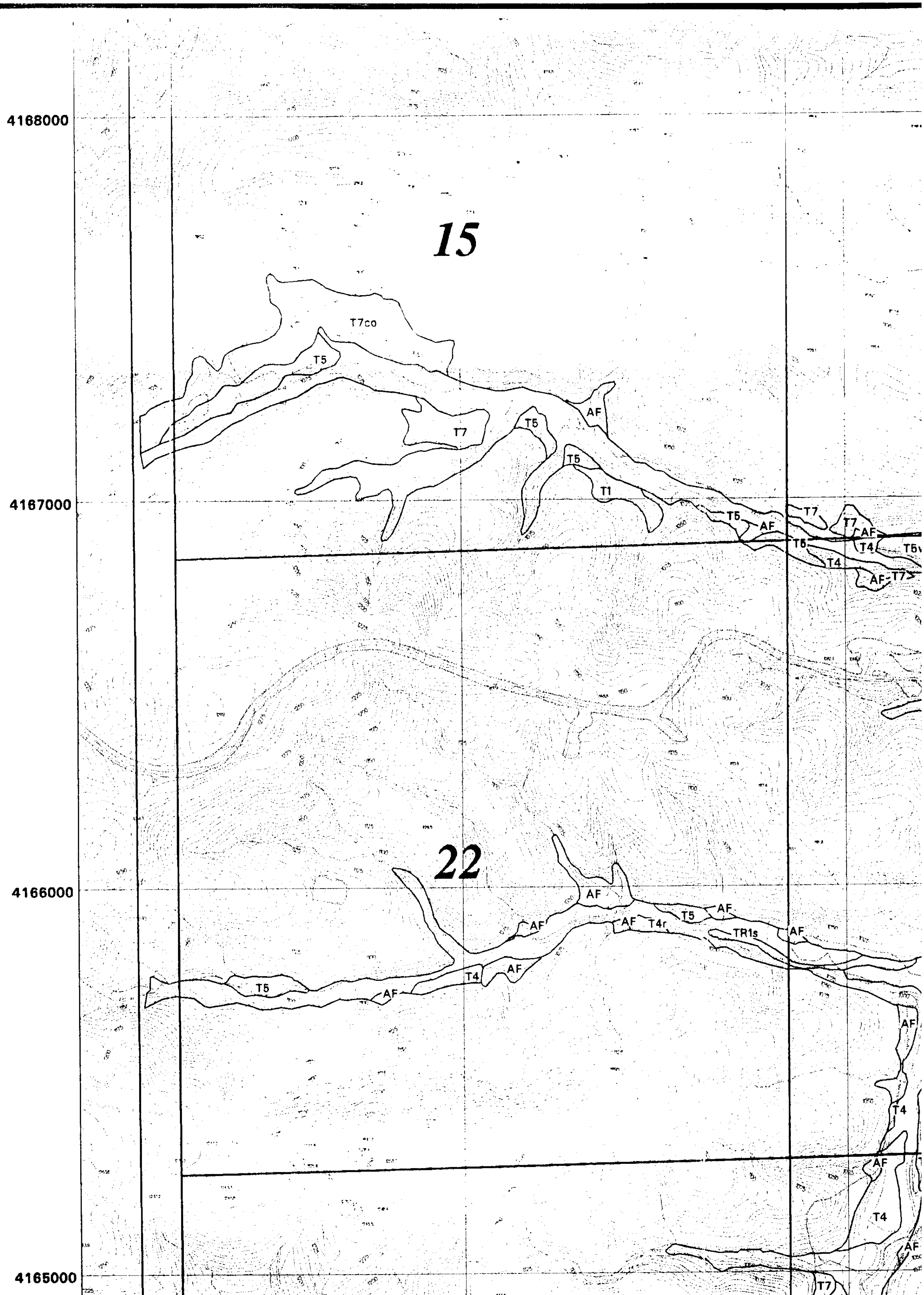
TR1
T2
T1s
T1
T1
AF
T1
T2
T2s
T5
AF
T5w
T5
T2
AF
T1s
T1
T2
T4
AF
T7co
T2
T2co
T2
T3
T2s
T5co
T5s
T3s
TR2
T5
AF
AF
AF
T7co
T5
T2s
T4
TR2
T4s
T5o
T4
11
12
AF
T2
T7
T4
T2s
T2
T1
AF
T5w
T7co
T3
T2
TR1
T1
T5
T5
T2
T2
T5s
T4
T4s
T1
T2s
T4
AF
T2
T1
T2
T7
T1
T1
T6w
T7
T6wo
T2
T5
T7
T6
TR2
T2
T5
T3
T3s
T6
T2
T2s
T3
T3
T6w
Og
T2
T3sw
AF
T2
T2
T0
T6
T5w
T1
T2
T5w
TR1
T5
T2s
T5wo
T7
T2
T6
T2
T7
T5
13
T5
T2
T2s
14
T2
T2
T2
T1
T4
T2s
T3
T3s
T2
T7
T5
T3
T4
T5
T7
T5w
T7wc
T6
T4

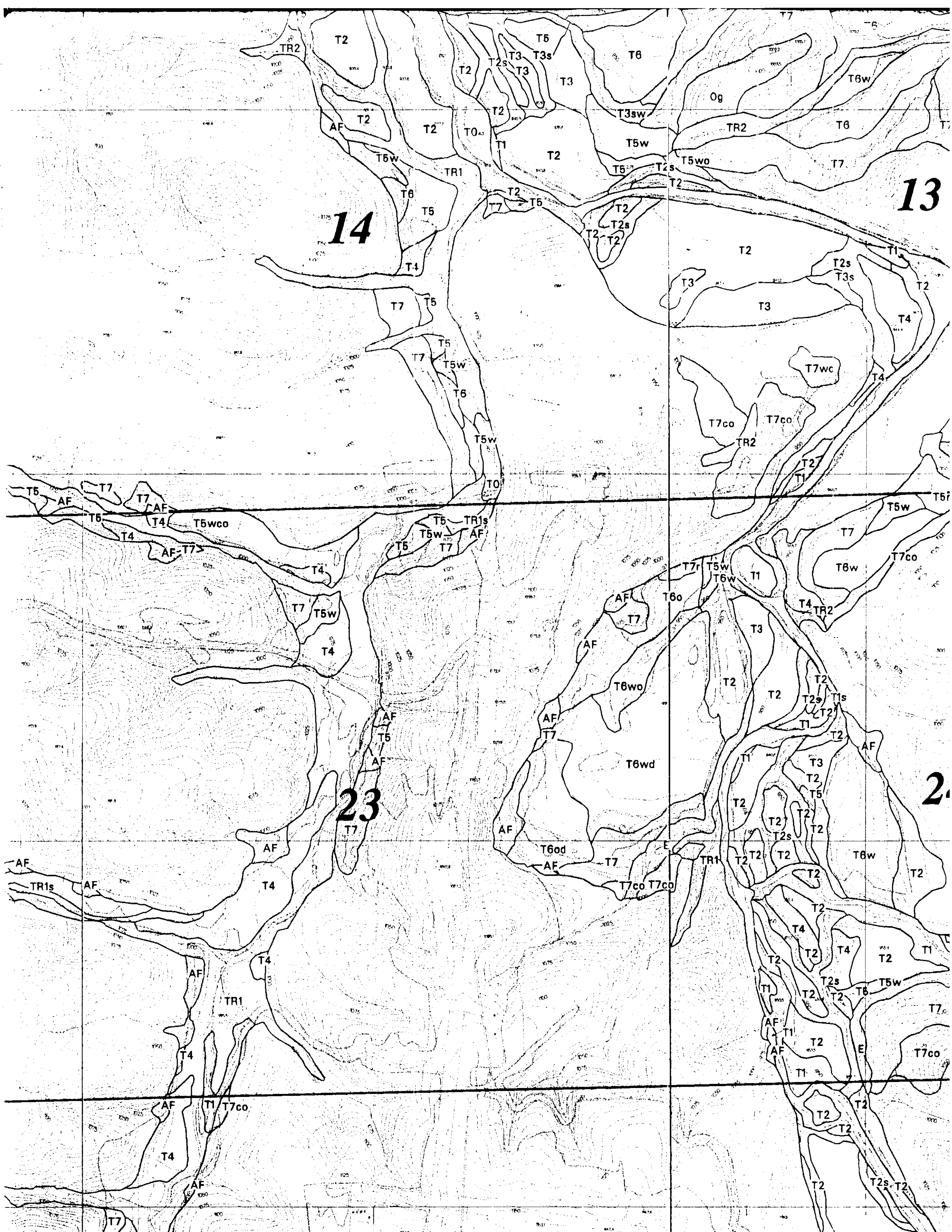


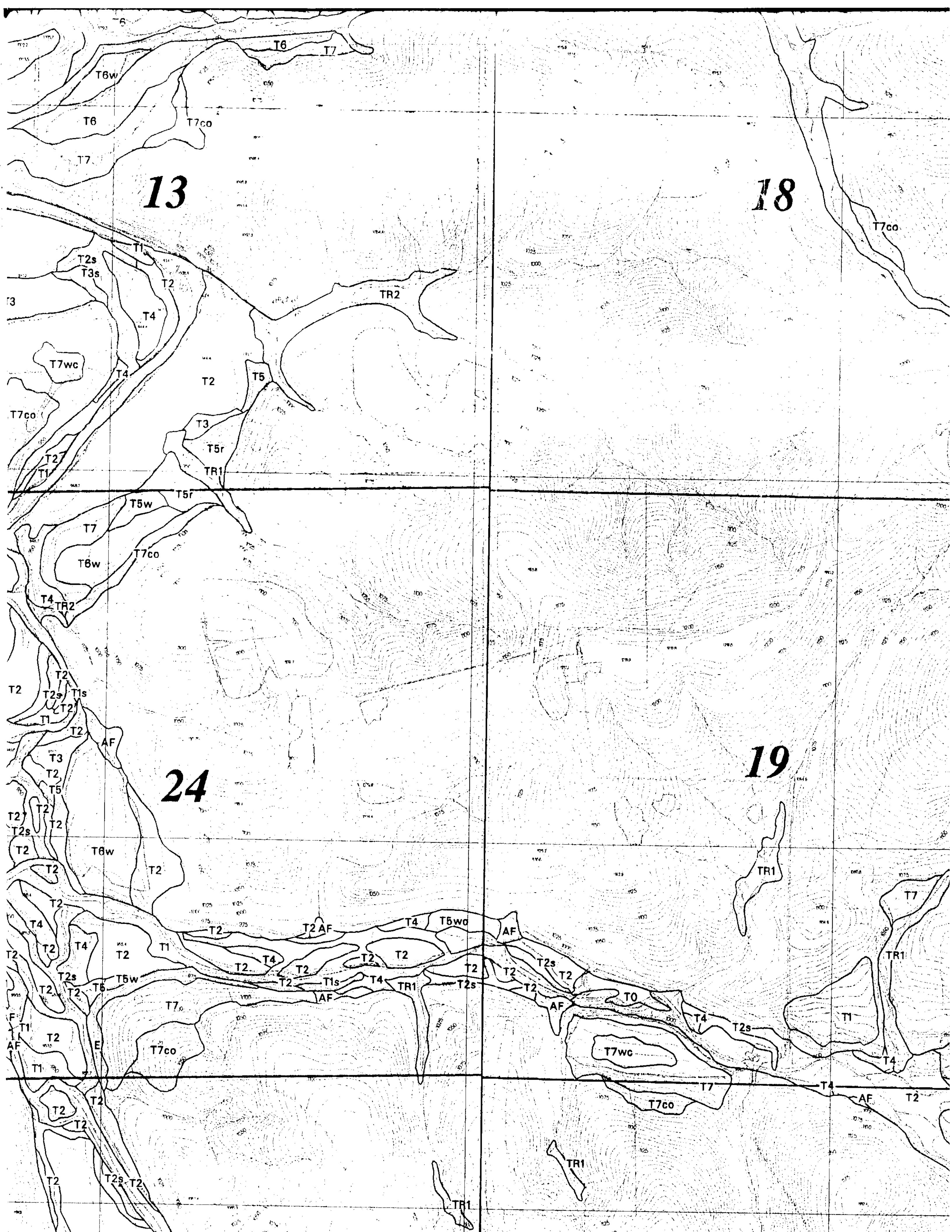
12
7
13
18
WATER
T1
T2
T2s
T3s
T4
T5
T5w
T5wo
T5d
T6
T6w
T6wo
T7
T7co
T7wc
TR2
AF


T5wo
AF
T4
T6
7
8
T5d
T6
AF
T7
TR1
AF
T7
AF
AF
T7co
18
T7co
17

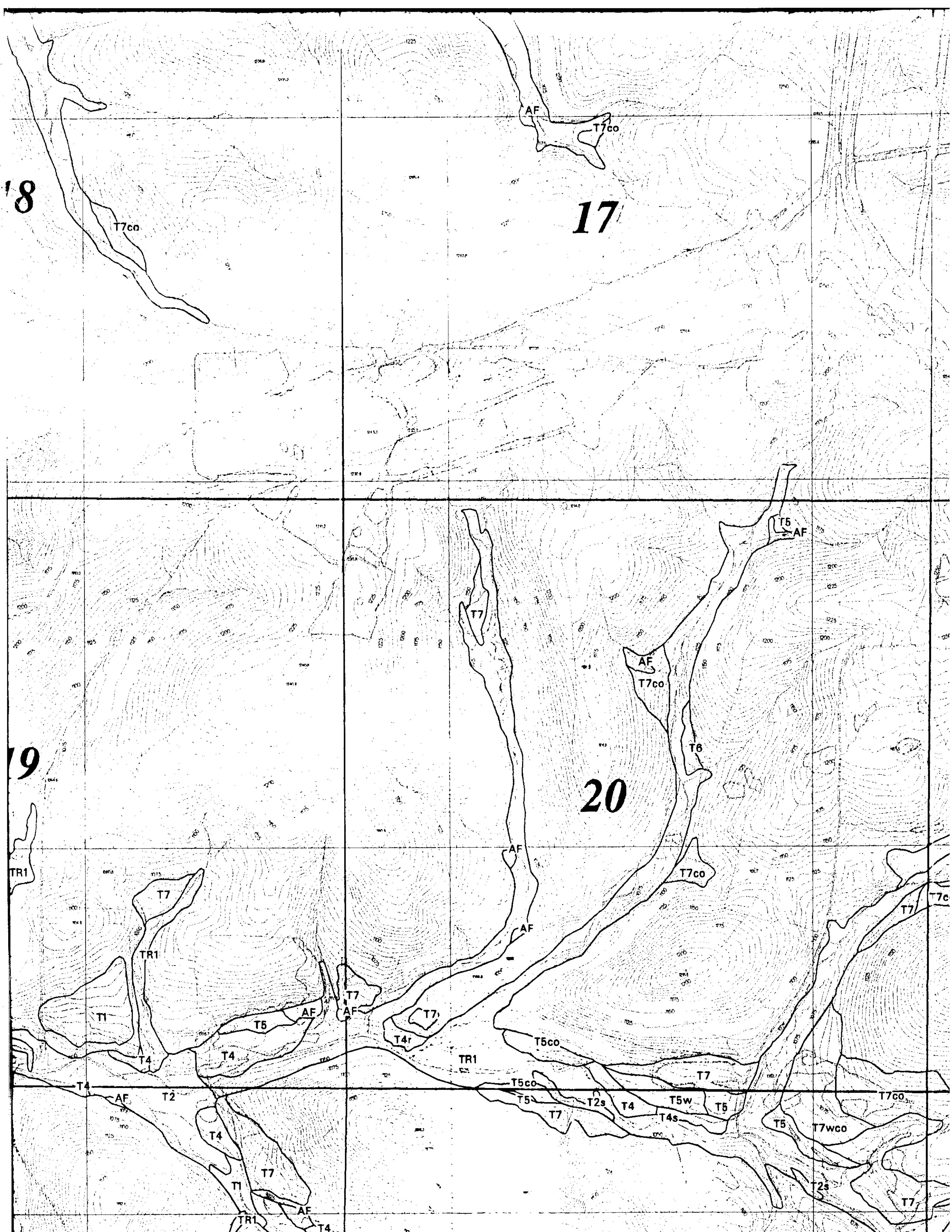

4170000
4169000
4168000
8
9
17
16
T7co
N


4168000
4167000
4166000
4165000
15
22
T7co
T5
T7
AF
T1
T4
T5v
T4r
TR1s

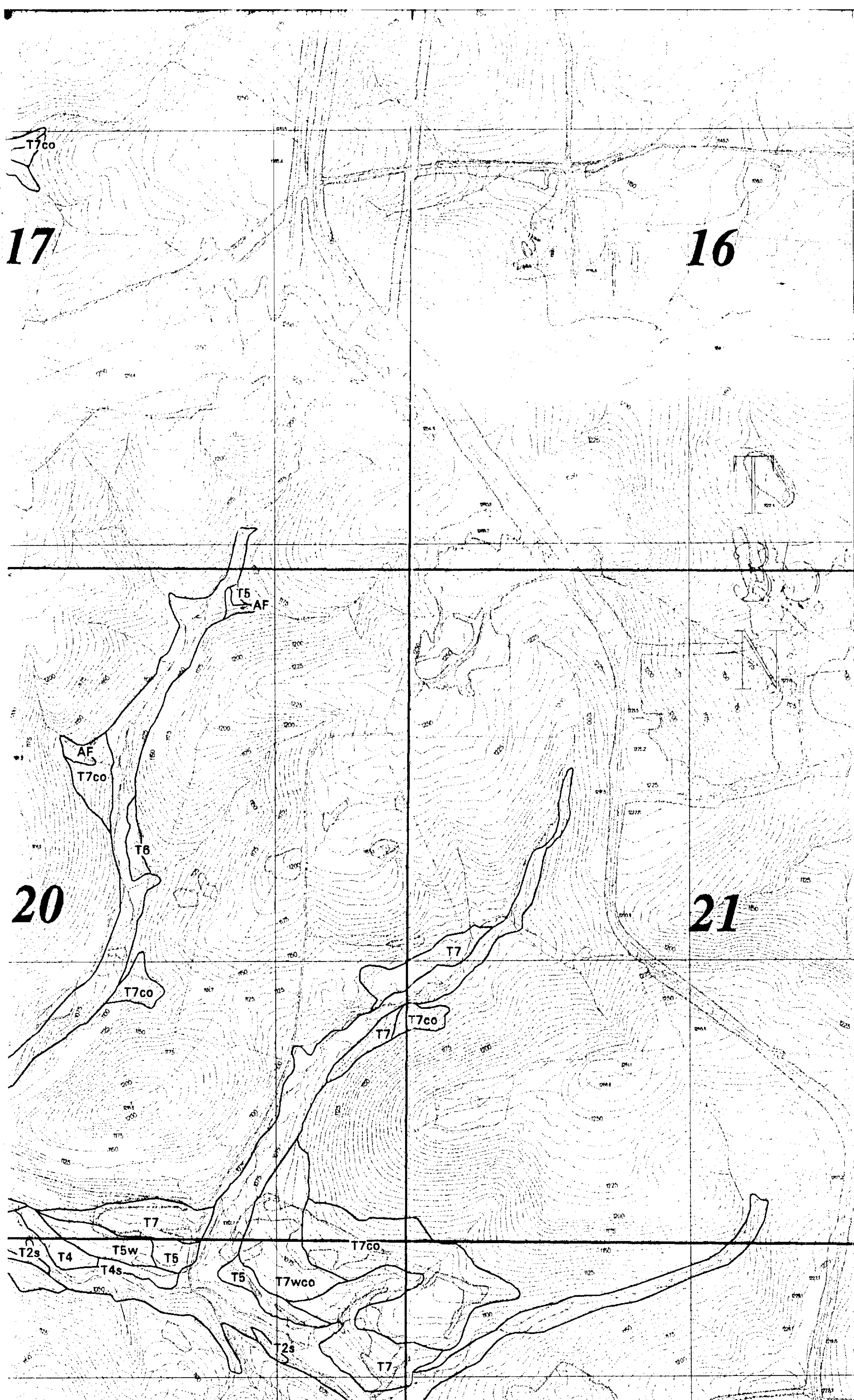

14
13
23
24
TR2
T2
T5
T3
T3s
T6
T7
T2s
T6w
Og
T3sw
AF
T0
T1
TR1
T5w
T5wo
T4
T2s
T3s
T7wc
T7co
T5wco
TR1s
T7r
T6o
T6wo
T6wd
T6od
T1s
E



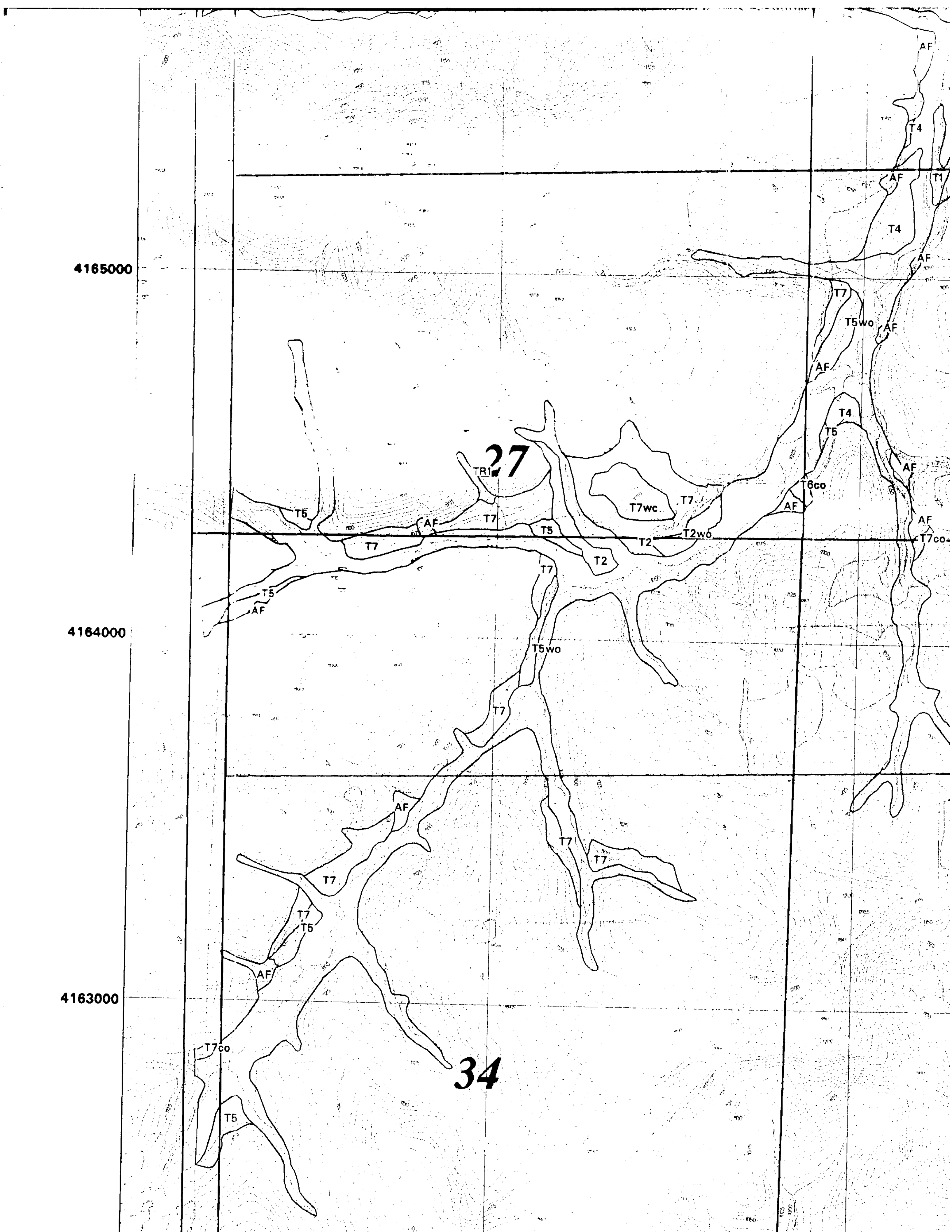
13
18
24
19
T6
T7
T6w
T6
T7co
T7
T7co
T1
T2s
T3s
T2
TR2
T3
T4
T7wc
T4
T2
T5
T7co
T3
T5r
T2
T1
TR1
T5w
T5r
T7
T6w
T7co
T4
TR2
T2
T2
T2s
T1s
T2
T1
T2
AF
T3
T2
T5
T2
T2
T2s
T2
T6w
T2
TR1
T7
T2
T2
T4
T2
T4
T2
T1
T2
T2 AF
T4
T5wo
AF
T4
T2
T2
T2
T2s
T2
TR1
T2s
T5
T5w
T2
T1s
T4
TR1
T2s
T2
T2
AF
T0
T4
T2s
T1
T7
AF
T1
T2
T7co
T7wc
AF
E
T1
T4
T2
T7
T4
AF
T2
T7co
T2
T2
TR1
T2
T2s
T2
TR1



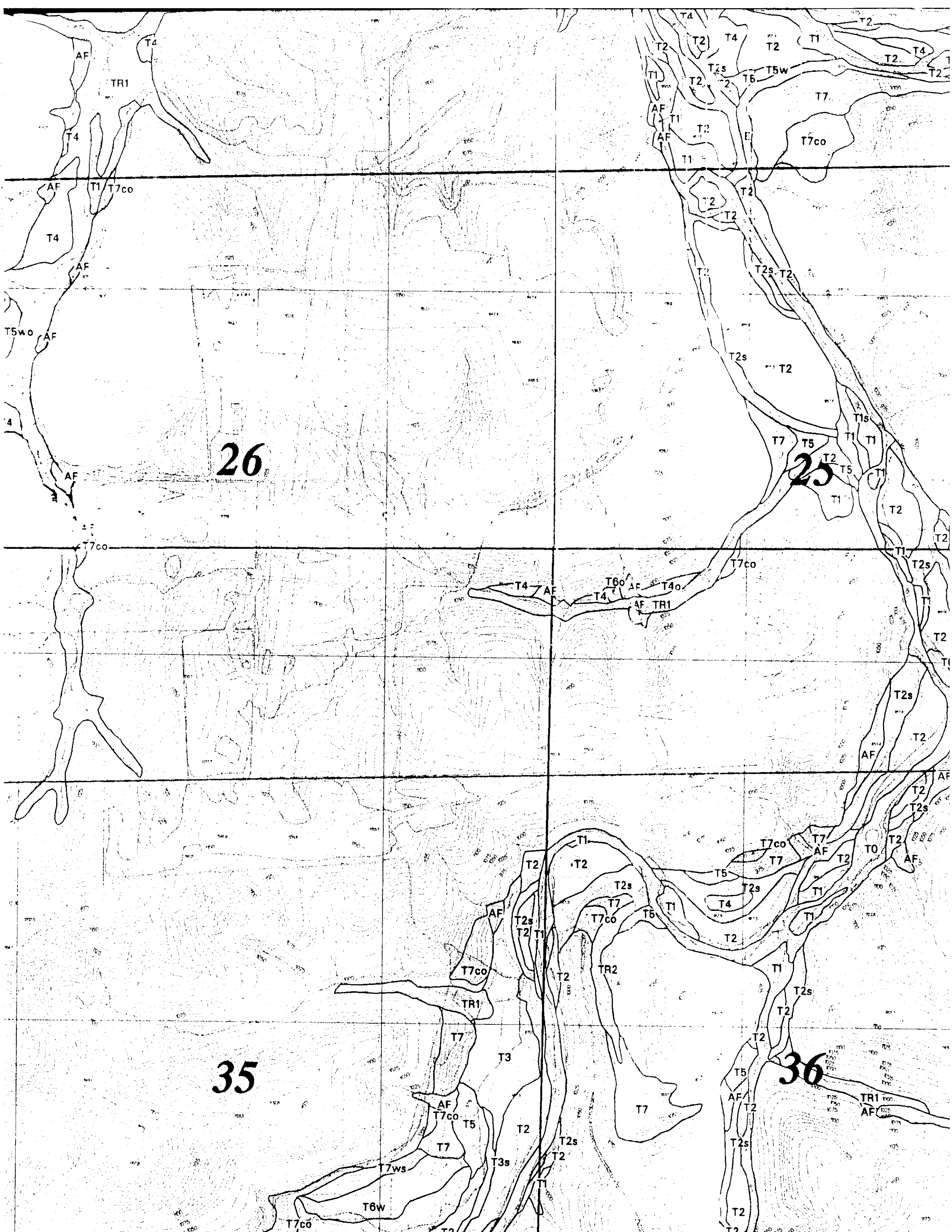
17
20
19
AF
T7co
T7
T6
T5
TR1
T1
T4
T4r
T5co
T2
T2s
T4s
T5w
T7wco

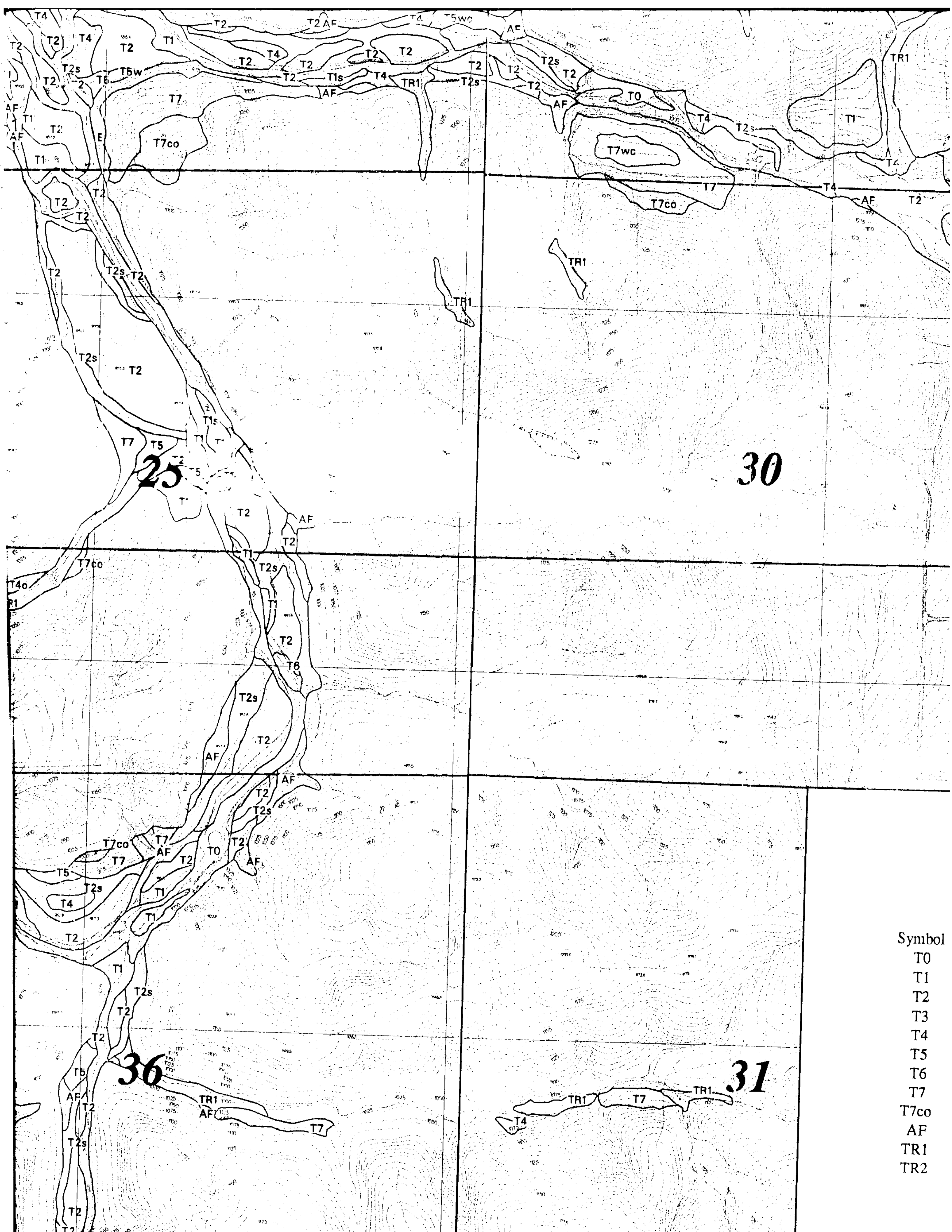


4168000
4167000
4166000
4165000
17
16
20
21
T7co
T5
AF
AF
T7co
T6
T7co
T7
T7
T7co
T7
T7co
T2s
T4
T5w
T4s
T5
T5
T7wco
T2s
T7

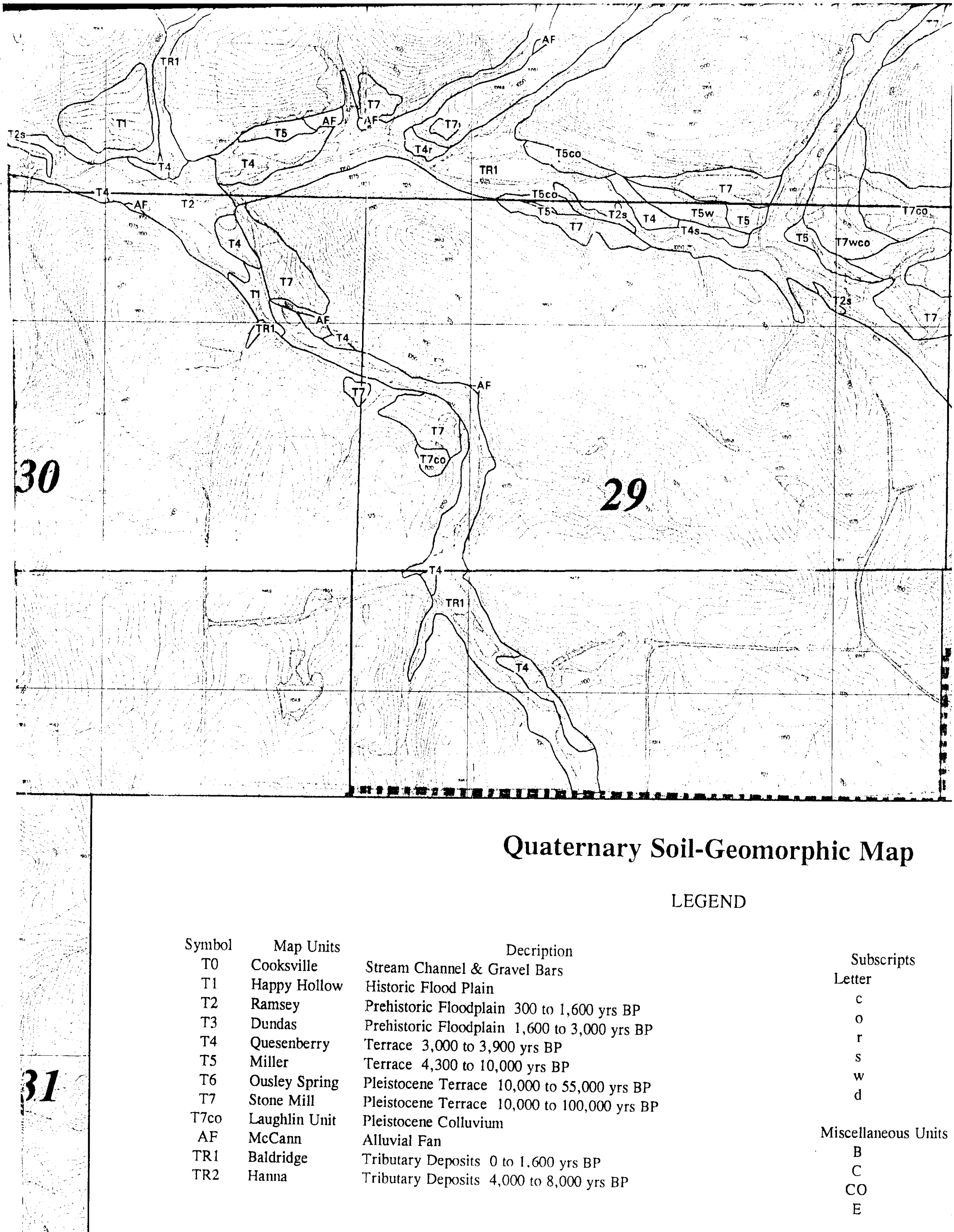


4165000
4164000
4163000
27
34
TR1
AF
T4
T1
T7
T5wo
T5
T6co
T7wc
T2
T2wo
T7co


26
25
35
36
TR1
T4
AF
T1
T7co
T5wo
T2
T2s
T5w
T5
T7
T1s
T6o
T4o
T0
TR2
T3
T3s
T7ws
T6w



Symbol
T0
T1
T2
T3
T4
T5
T6
T7
T7co
AF
TR1
TR2



Quaternary Soil-Geomorphic Map

LEGEND

Symbol	Map Units	Decription
T0	Cooksville	Stream Channel & Gravel Bars
T1	Happy Hollow	Historic Flood Plain
T2	Ramsey	Prehistoric Floodplain 300 to 1,600 yrs BP
T3	Dundas	Prehistoric Floodplain 1,600 to 3,000 yrs BP
T4	Quesenberry	Terrace 3,000 to 3,900 yrs BP
T5	Miller	Terrace 4,300 to 10,000 yrs BP
T6	Ousley Spring	Pleistocene Terrace 10,000 to 55,000 yrs BP
T7	Stone Mill	Pleistocene Terrace 10,000 to 100,000 yrs BP
T7co	Laughlin Unit	Pleistocene Colluvium
AF	McCann	Alluvial Fan
TR1	Baldridge	Tributary Deposits 0 to 1,600 yrs BP
TR2	Hanna	Tributary Deposits 4,000 to 8,000 yrs BP

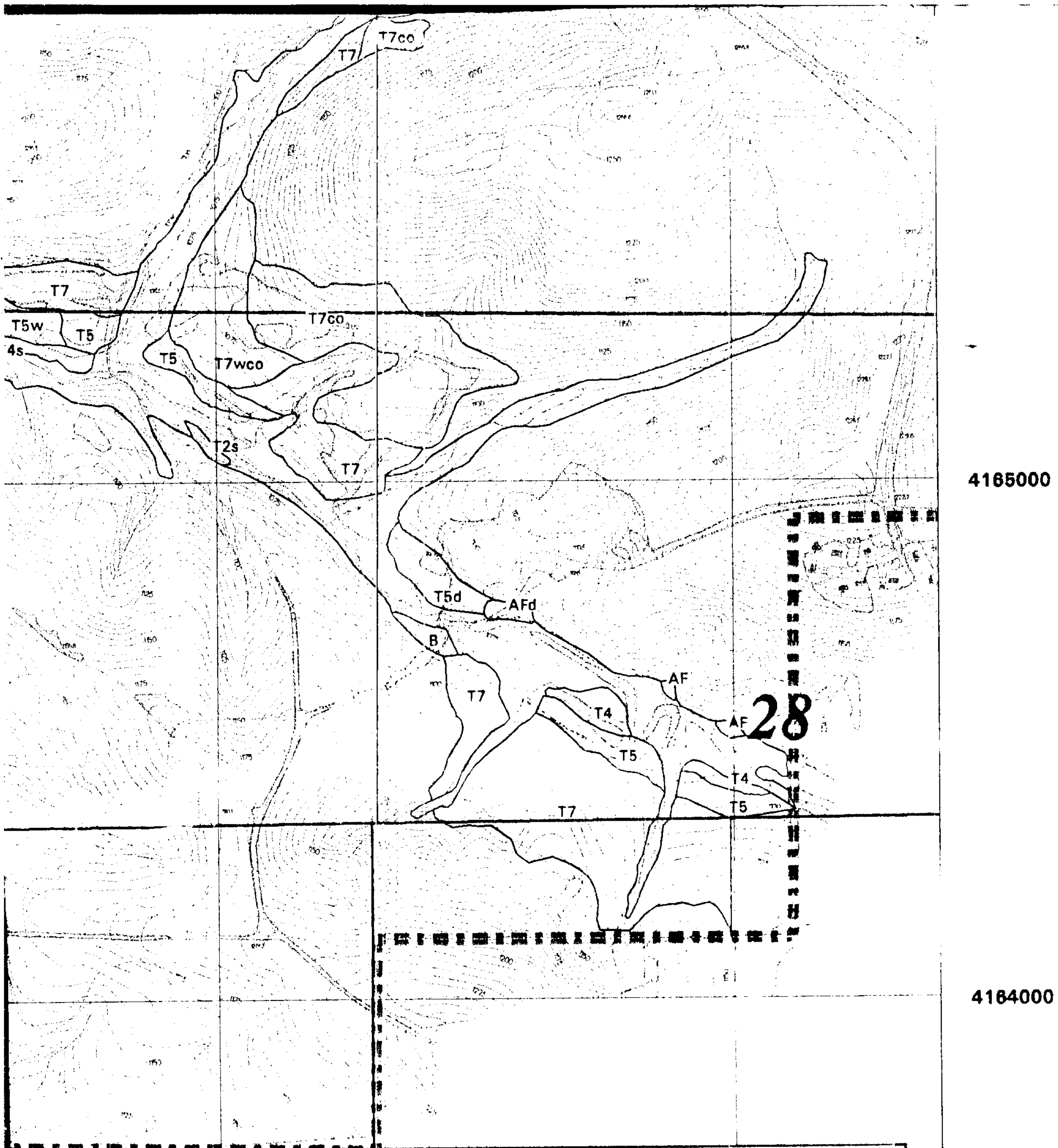
Subscripts

Letter

c
o
r
s
w
d

Miscellaneous Units

B
C
CO
E



4163000

il-Geomorphic Map

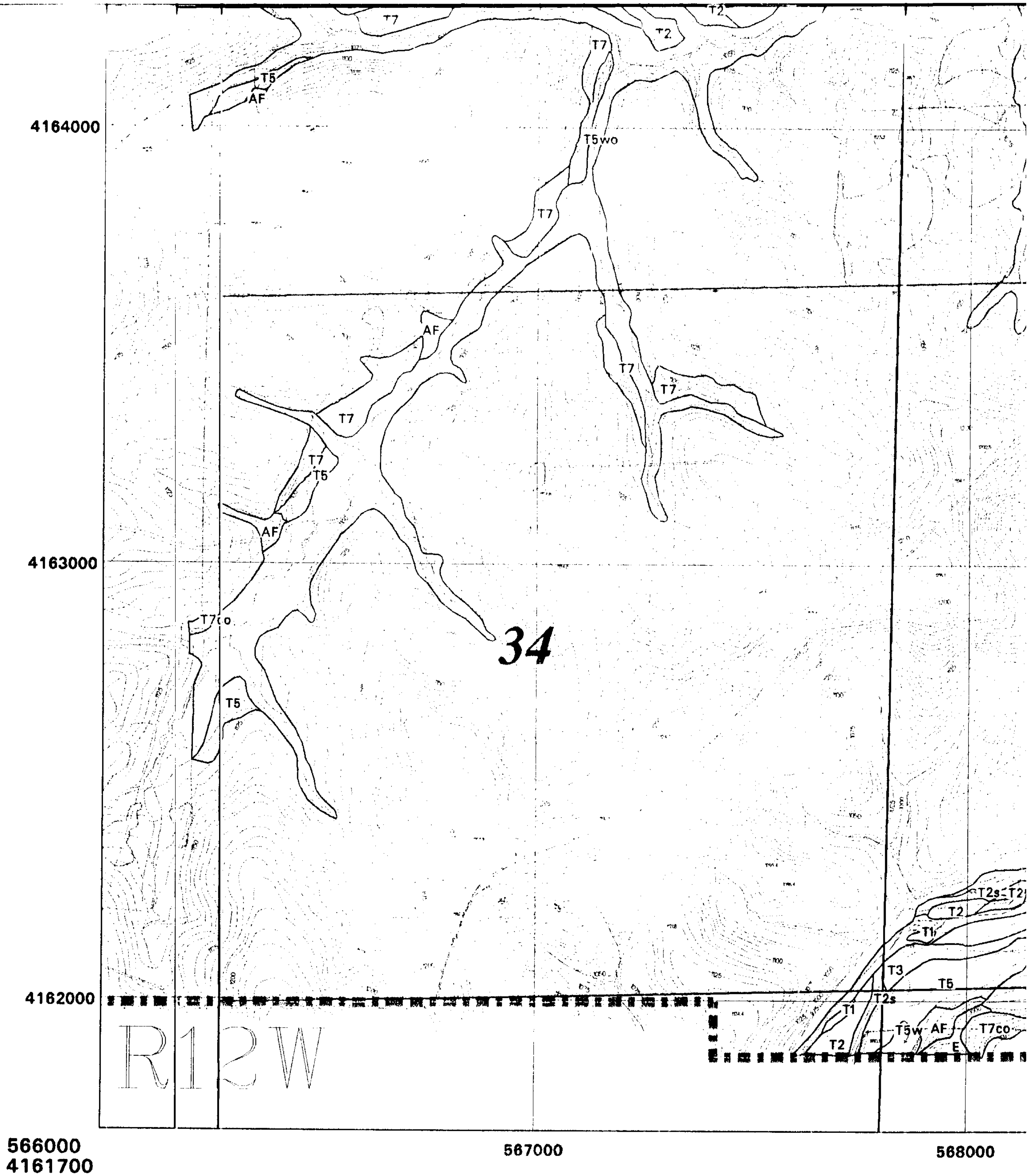
EGEND

Subscripts

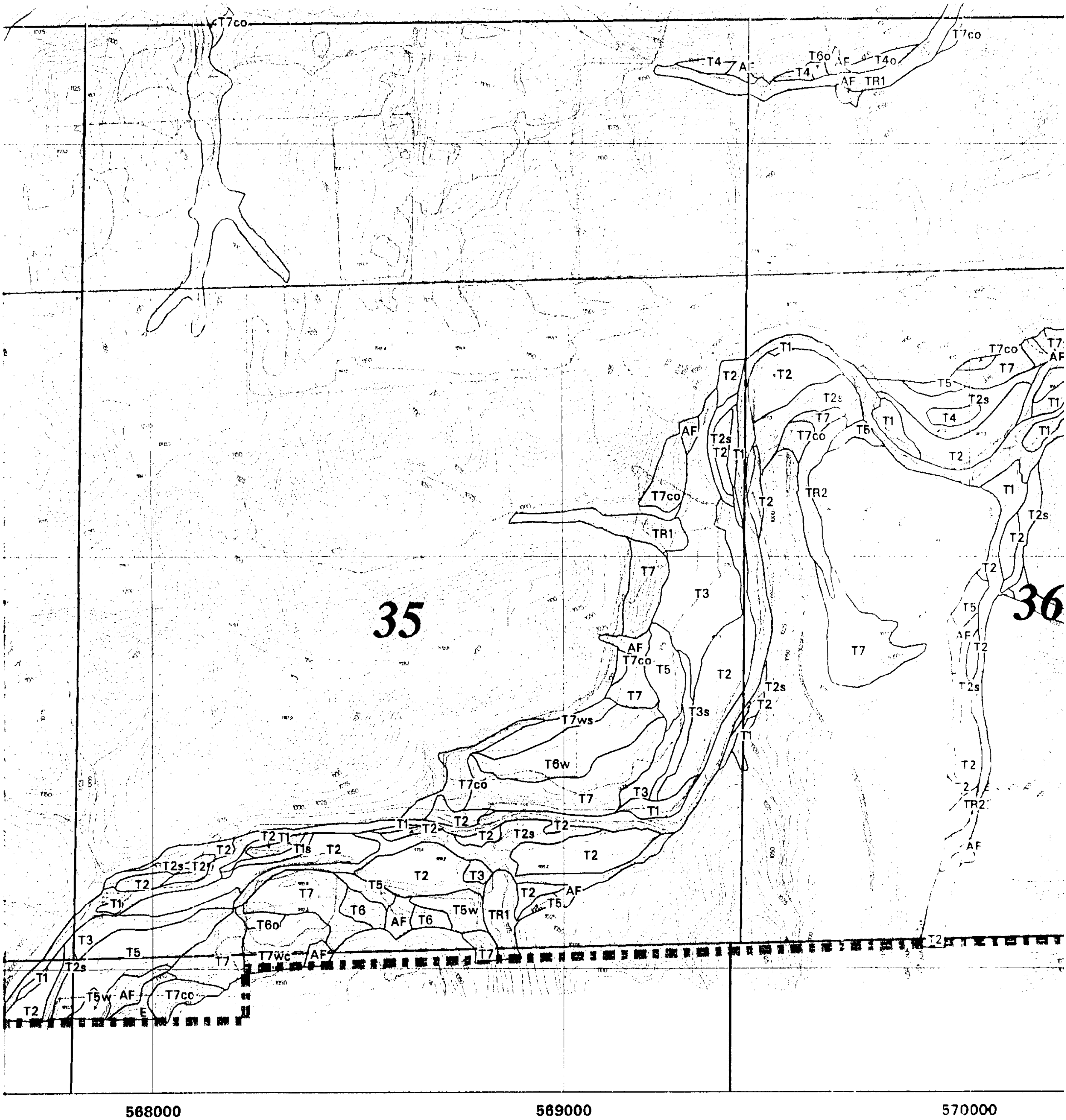
Letter	Soil Property
c	Clayey Soil
o	Dark Surface
r	>35% Gravel
s	Slough
w	Wet Soil
d	Disturbed

Miscellaneous Units

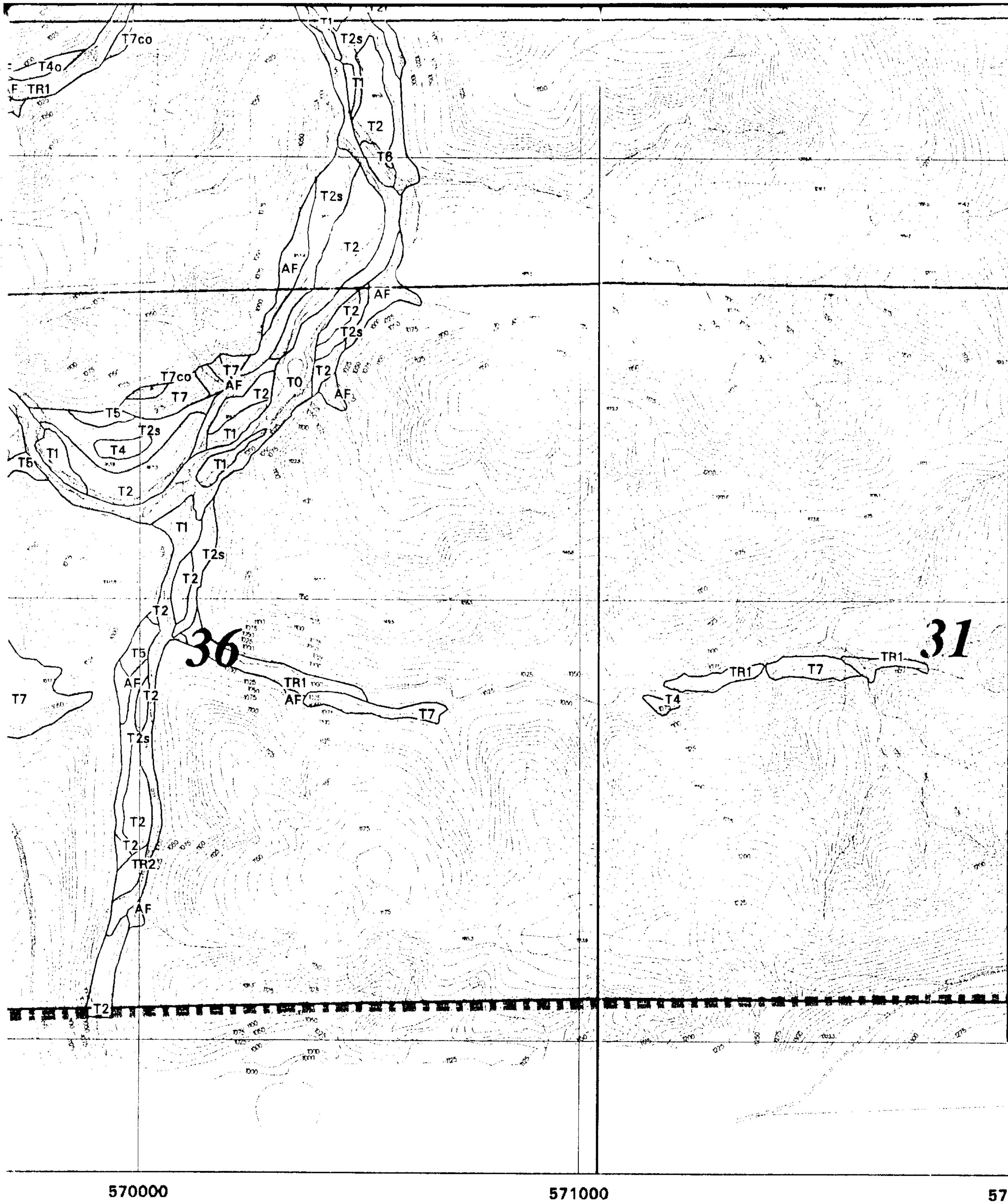
B	Borrow area
C	Construction
CO	Colluvial wedge area
E	Escarpment W/O bedrock



4164000
4163000
4162000
566000
4161700
567000
568000
34
R12W
T7
T2
T5
AF
T5wo
T7co
T2s
T1
T3
T5w
E



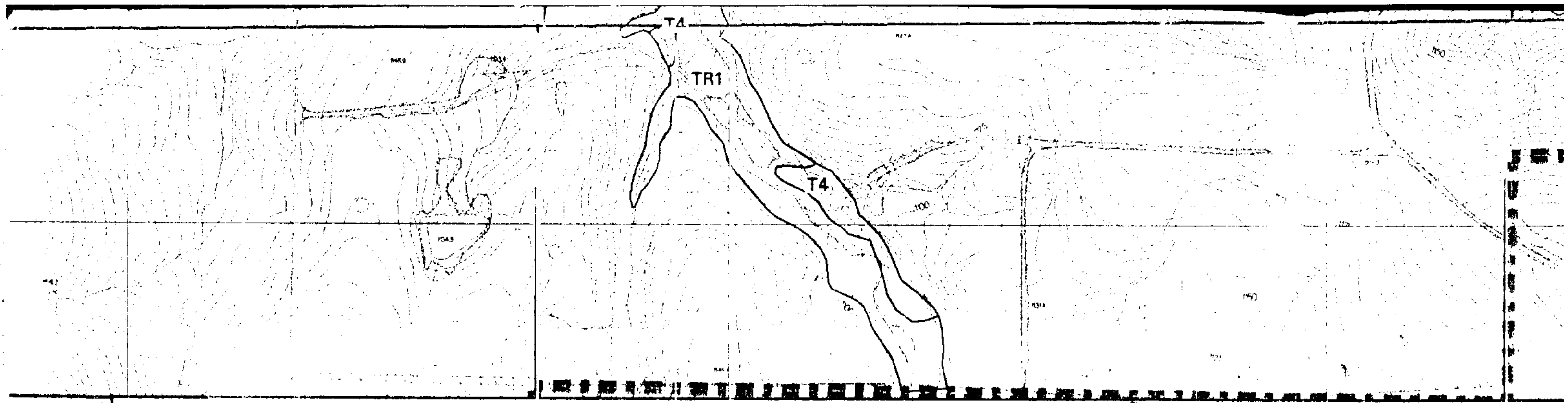
35
36
T7co
T4
AF
T6o
T4o
TR1
T1
T2
T2s
T7
T5
T4
TR2
T7co
TR1
T3
T7
AF
T5
T3s
T7ws
T6w
T1s
T6o
T7wc
T5w
T6
TR1
T7cc
E
568000
569000
570000



Sy

T
T7
A
T
T

Metadata
and Butle
units wer
Master P
Missouri
elevation



Quaternary Soil-Geomorphic Map

LEGEND

Symbol	Map Units	Decription
T0	Cooksville	Stream Channel & Gravel Bars
T1	Happy Hollow	Historic Flood Plain
T2	Ramsey	Prehistoric Floodplain 300 to 1,600 yrs BP
T3	Dundas	Prehistoric Floodplain 1,600 to 3,000 yrs BP
T4	Quesenberry	Terrace 3,000 to 3,900 yrs BP
T5	Miller	Terrace 4,300 to 10,000 yrs BP
T6	Ousley Spring	Pleistocene Terrace 10,000 to 55,000 yrs BP
T7	Stone Mill	Pleistocene Terrace 10,000 to 100,000 yrs BP
T7co	Laughlin Unit	Pleistocene Colluvium
AF	McCann	Alluvial Fan
TR1	Baldridge	Tributary Deposits 0 to 1,600 yrs BP
TR2	Hanna	Tributary Deposits 4,000 to 8,000 yrs BP

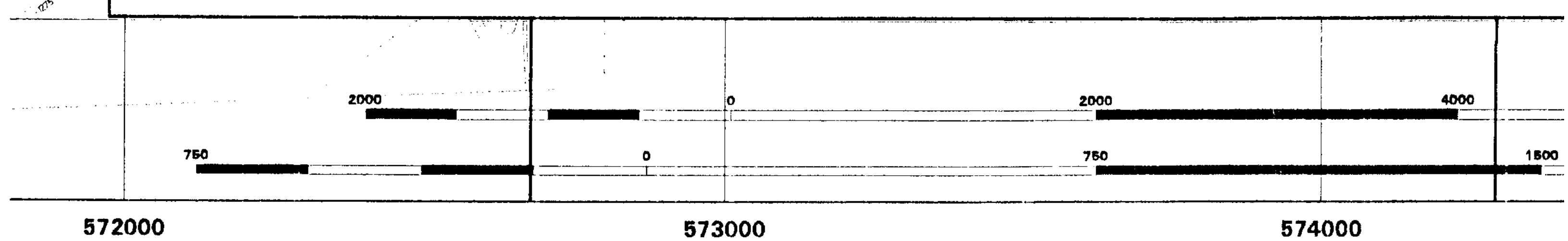
Subscripts

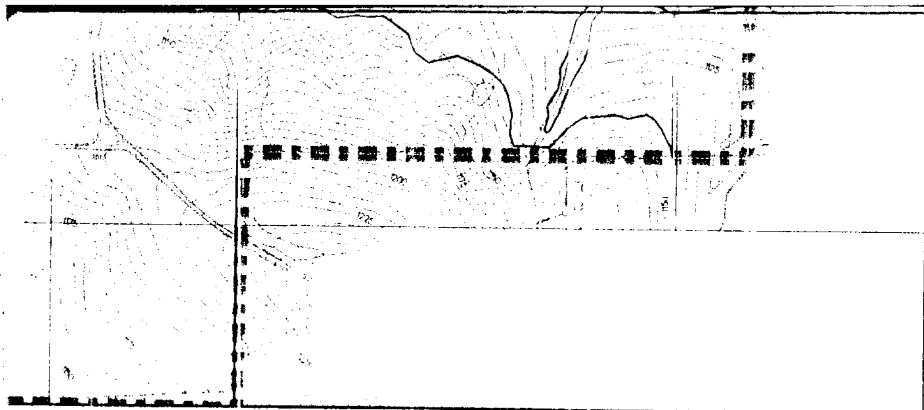
Letter	So
c	Cla
o	Dar
r	>3
s	Slo
w	We
d	Dis

Miscellaneous Units

B	Bor
C	Cor
CO	Col
E	Esc

Metadata Note! Soil-geomorphic units, shown as black polygons, were derived from field mapping conducte
and Butler 1995. Detailed description of the soil-geomorphic units and their archaeological potential are cont
units were digitized in longitude and latitude using AutoCad. The cultural features and contours, shown as
Master Plan Basic Information Map created by MSE corporation, Indianapolis, IN, for Fort Leonard Wood
Missouri State Plane coordinates. All data are translated to the UTM projection, Zone 15 using Arcinfo. T
elevation data are in feet. Map synthesis and production was performed by Information Management Systems,





4164000

4163000

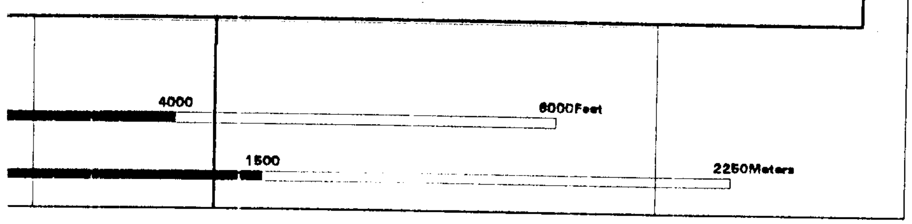
4162000

ɔhic Map

Subscripts Letter	Soil Property
c	Clayey Soil
o	Dark Surface
r	>35% Gravel
s	Slough
w	Wet Soil
d	Disturbed

Miscellaneous Units	
B	Borrow area
C	Construction
CO	Colluvial wedge area
E	Escarpment W/O bedrock

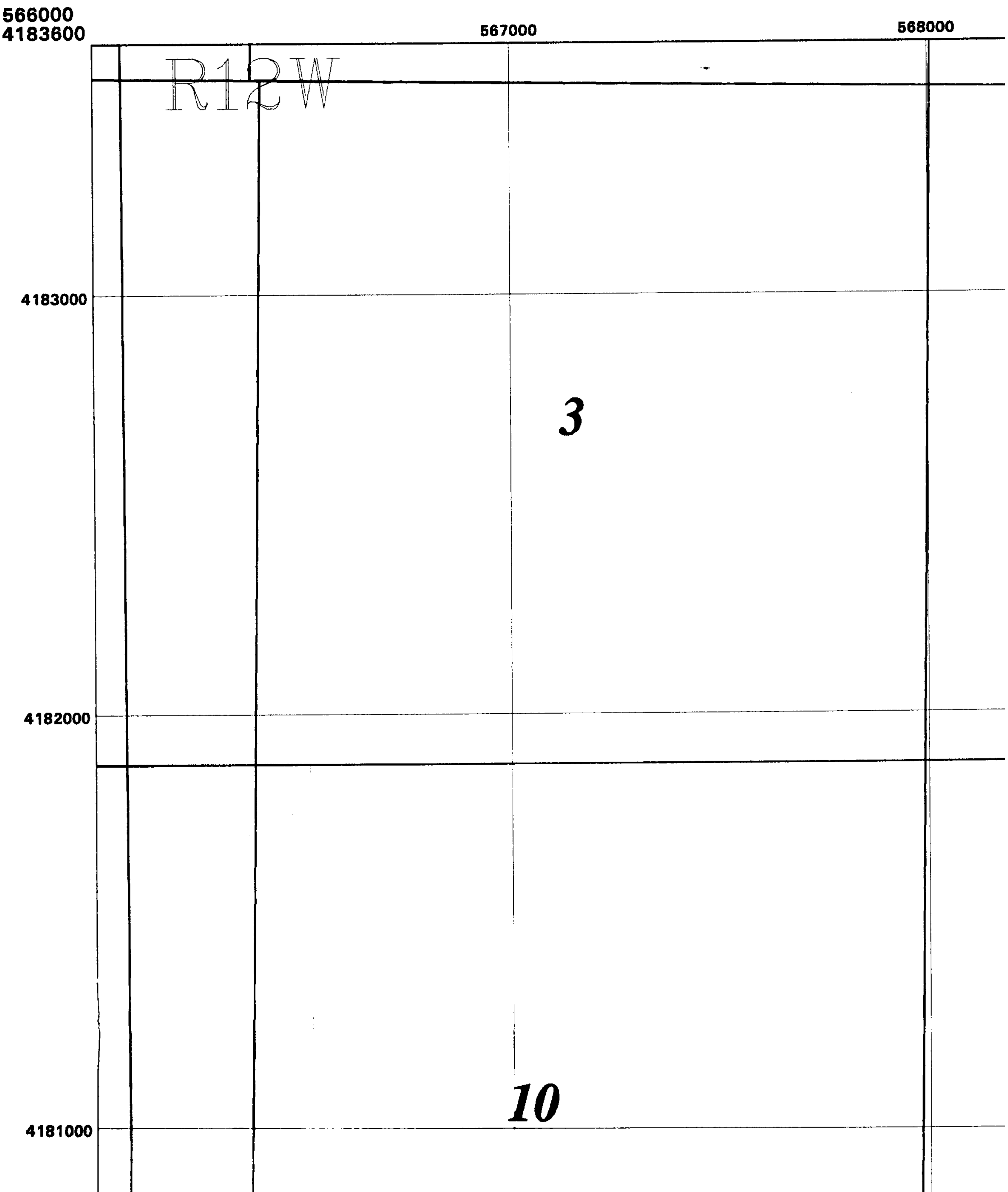
eld mapping conducted during this study, Albertson,Meinert,
ical potential are contained in the text. The soil-geomorphic
l contours, shown as half-tones, were derived from the 1992
· Fort Leonard Wood in Intergraph Design File format using
15 using Arcinfo. The UTM grid is in meters. The contour
Management Systems, Inc.,Vicksburg, MS in August 1995.



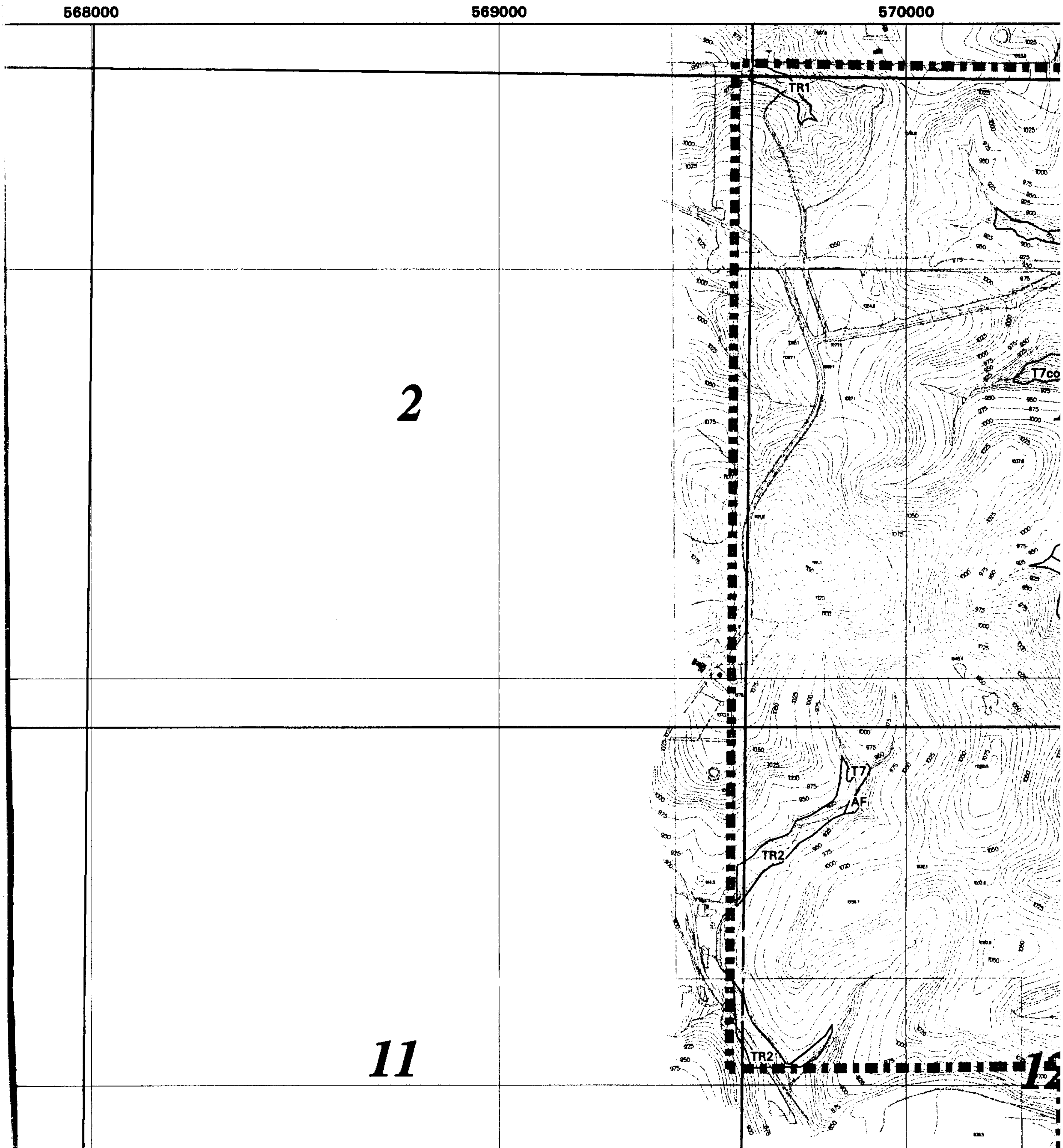
74000

575000

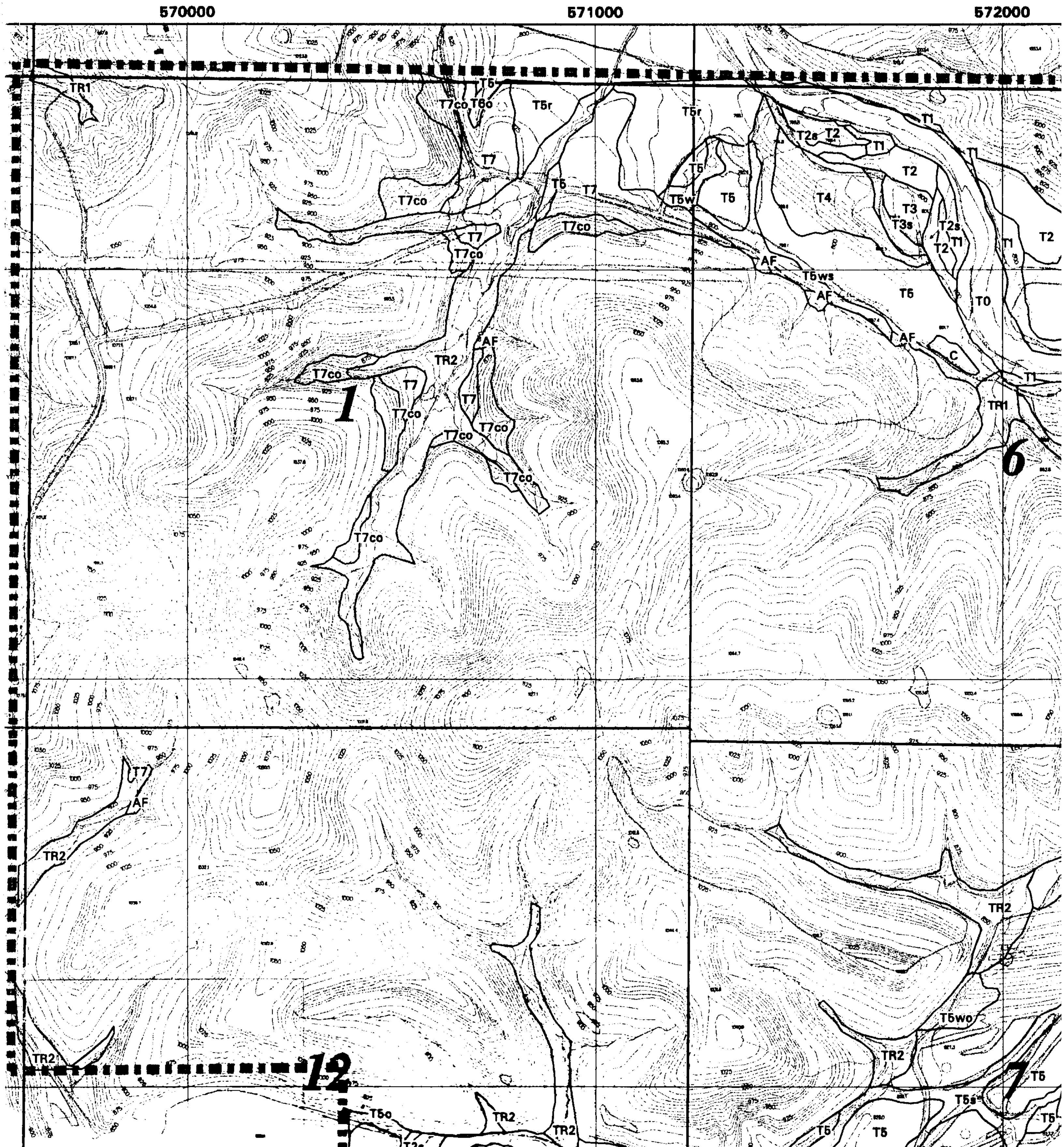
575400
4161700


566000
4183600
567000
568000
R12W
4183000
3
4182000
10
4181000

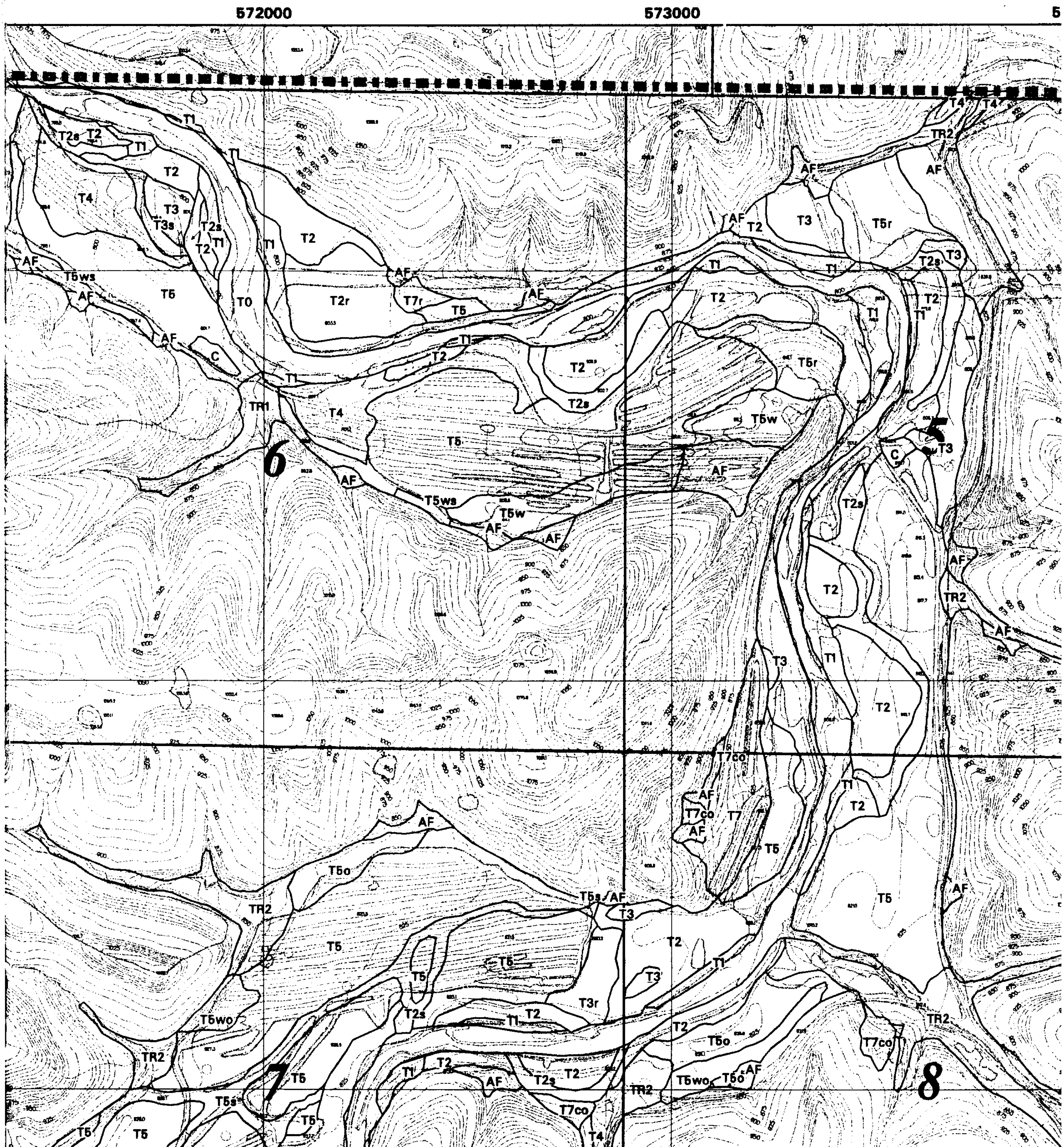
Lower Ro



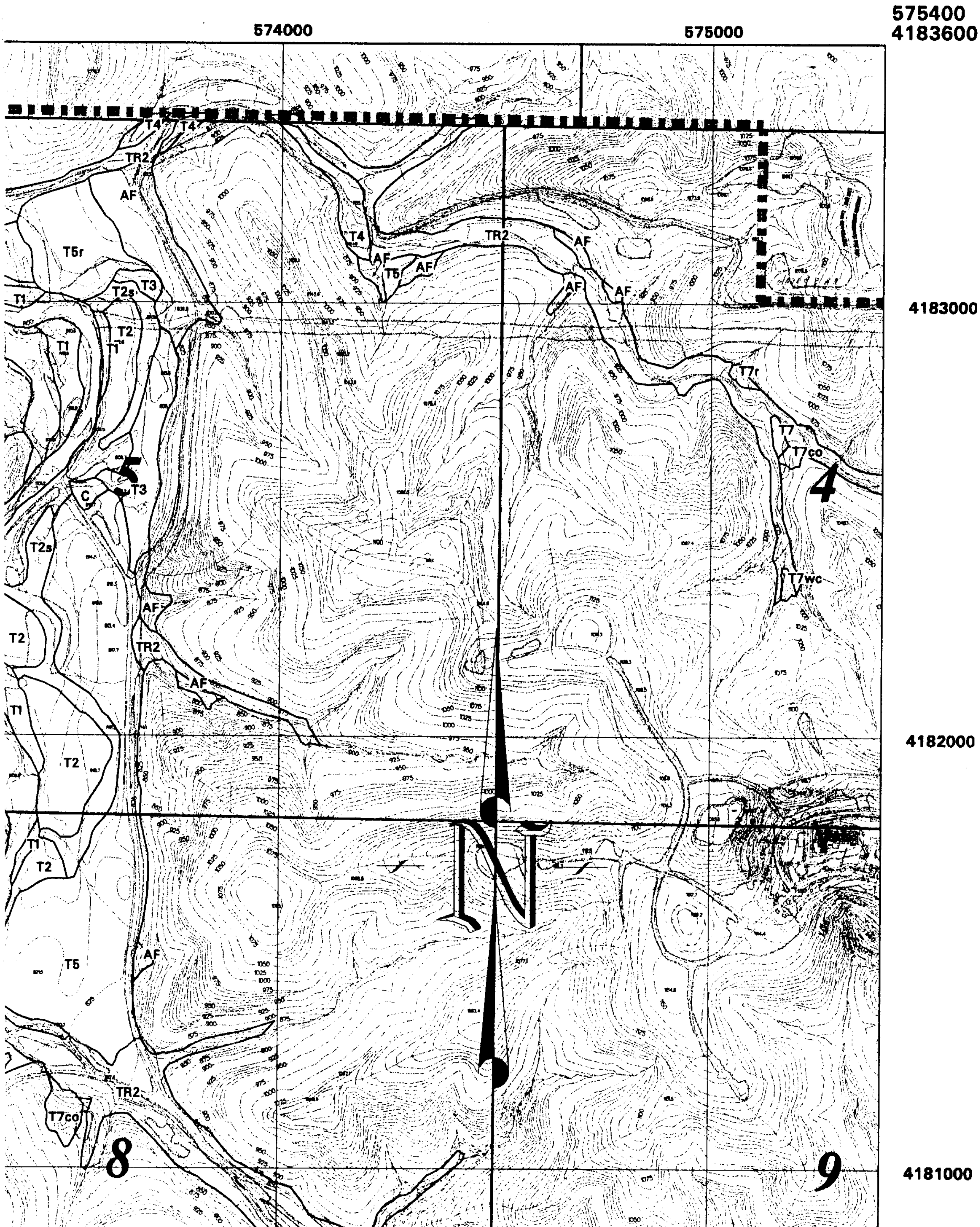
'ver Roubidoux Cre



x Creek



572000
573000
T1
T2s
T2
T1
T2
T4
T3
T3s
T2s
T2
T1
T1
T2
AF
T5ws
AF
T5
T0
T2r
T7r
T5
AF
AF
C
T1
T2
TR1
T4
T5
6
AF
T5ws
T5w
AF
AF
T2
T2s
T5r
T5w
AF
AF
T2
T3
T5r
T1
T2s
T3
T2
T1
T1
T4
T4
TR2
AF
C
T3
5
T2s
AF
T2
TR2
AF
T3
T1
T2
T7co
AF
T7co
T7
AF
T5
T1
T2
AF
T5o
T5s
AF
T3
TR2
T5
T2
T5
T1
T3
T3r
T5
T2s
T1
T2
T5wo
TR2
T2
T5o
T7co
TR2
8
7
T5
T1
T2
AF
T2s
T2
T5wo
T5o
AF
TR2
T5s
T5
T7co
T4
T5
T5



574000
575000
575400
4183600
4183000
4182000
4181000
T4
TR2
AF
T5r
T2s
T3
T1
T2
T7r
T7
T7co
T7wc
C
T5
N
4
5
8
9

4181000

10

4180000

Quaternary Soil-Geomorph

LEGEND

Symbol	Map Units	Decription
T0	Cooksville	Stream Channel & Gravel Bars
T1	Happy Hollow	Historic Flood Plain
T2	Ramsey	Prehistoric Floodplain 300 to 1,600 yrs BP
T3	Dundas	Prehistoric Floodplain 1,600 to 3,000 yrs BP
T4	Quesenberry	Terrace 3,000 to 3,900 yrs BP
T5	Miller	Terrace 4,300 to 10,000 yrs BP
T6	Ousley Spring	Pleistocene Terrace 10,000 to 55,000 yrs BP
T7	Stone Mill	Pleistocene Terrace 10,000 to 100,000 yrs BP
T7co	Laughlin Unit	Pleistocene Colluvium
AF	McCann	Alluvial Fan
TR1	Baldridge	Tributary Deposits 0 to 1,600 yrs BP
TR2	Hanna	Tributary Deposits 4,000 to 8,000 yrs BP

4179000

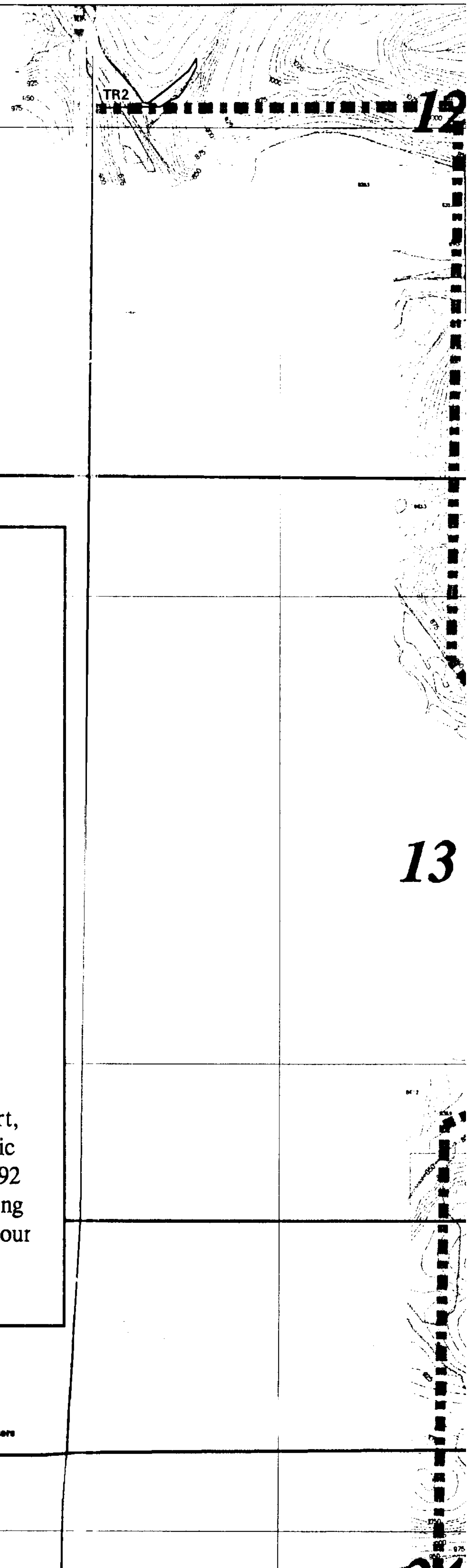
Metadata Note! Soil-geomorphic units, shown as black polygons, were derived from field
and Butler 1995. Detailed description of the soil-geomorphic units and their archaeologica
units were digitized in longitude and latitude using AutoCad. The cultural features and c
Master Plan Basic Information Map created by MSE corporation, Indianapolis, IN, for F
Missouri State Plane coordinates. All data are translated to the UTM projection, Zone 15
elevation data are in feet. Map synthesis and production was performed by Information Ma

2000 0 2000

750 0 750

4178000

11



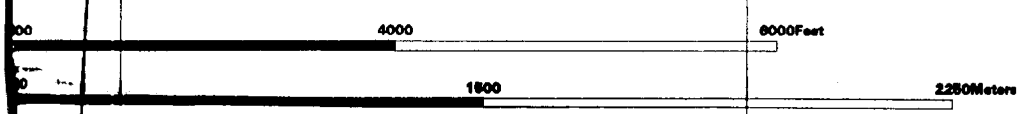
l-Geomorphic Map

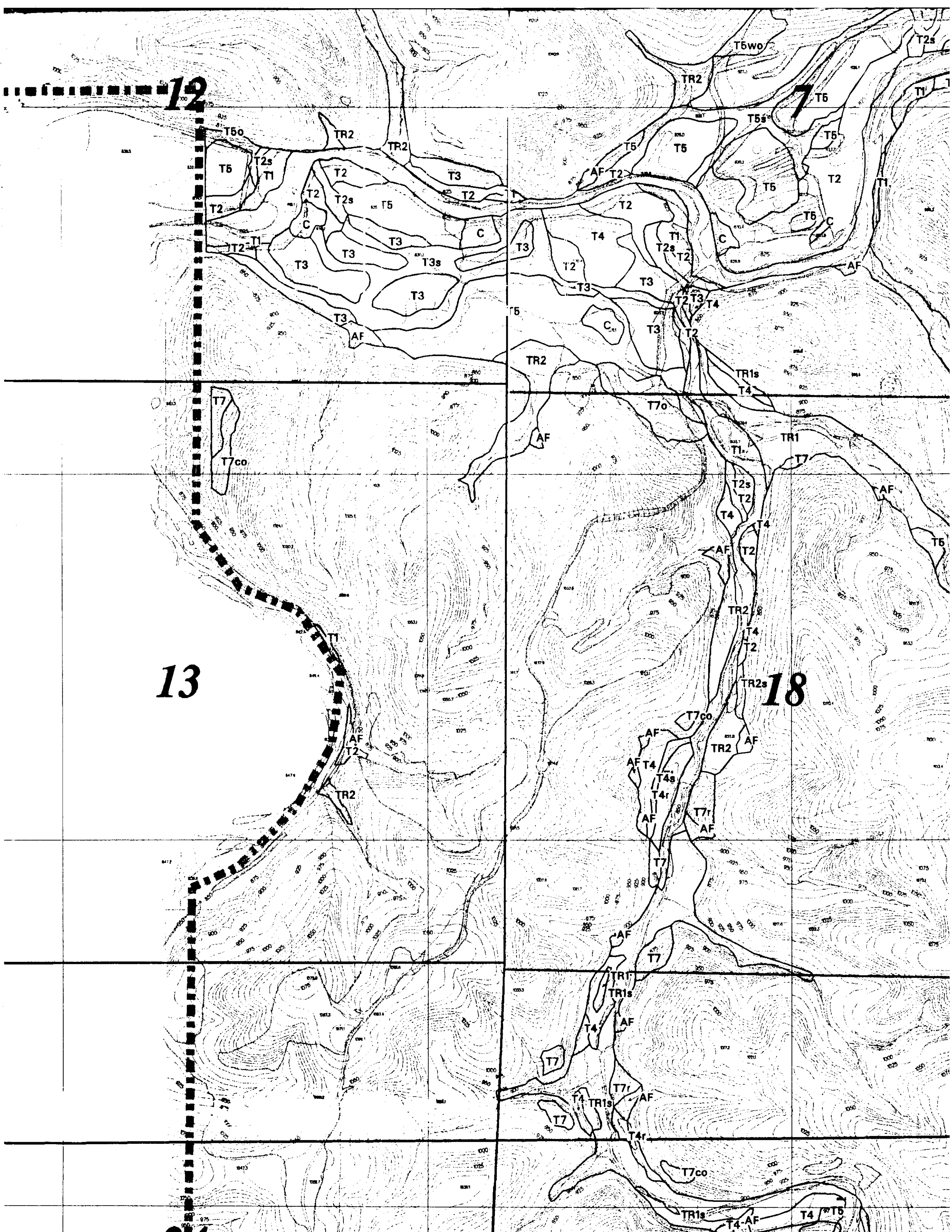
EGEND

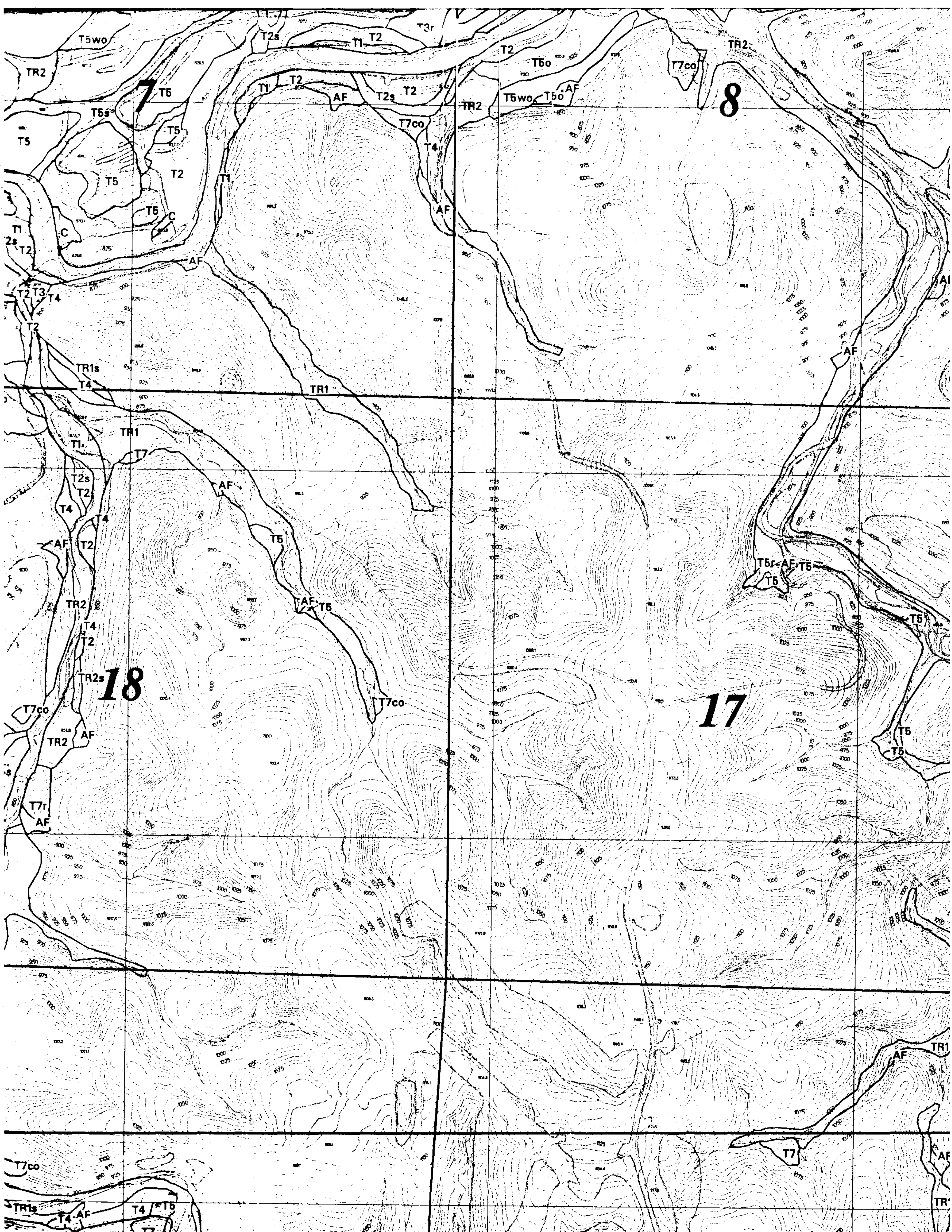
Subscripts Letter	Soil Property
c	Clayey Soil
o	Dark Surface
r	>35% Gravel
s	Slough
w	Wet Soil
d	Disturbed

Miscellaneous Units	
B	Borrow area
C	Construction
CO	Colluvial wedge area
E	Escarpment W/O bedrock

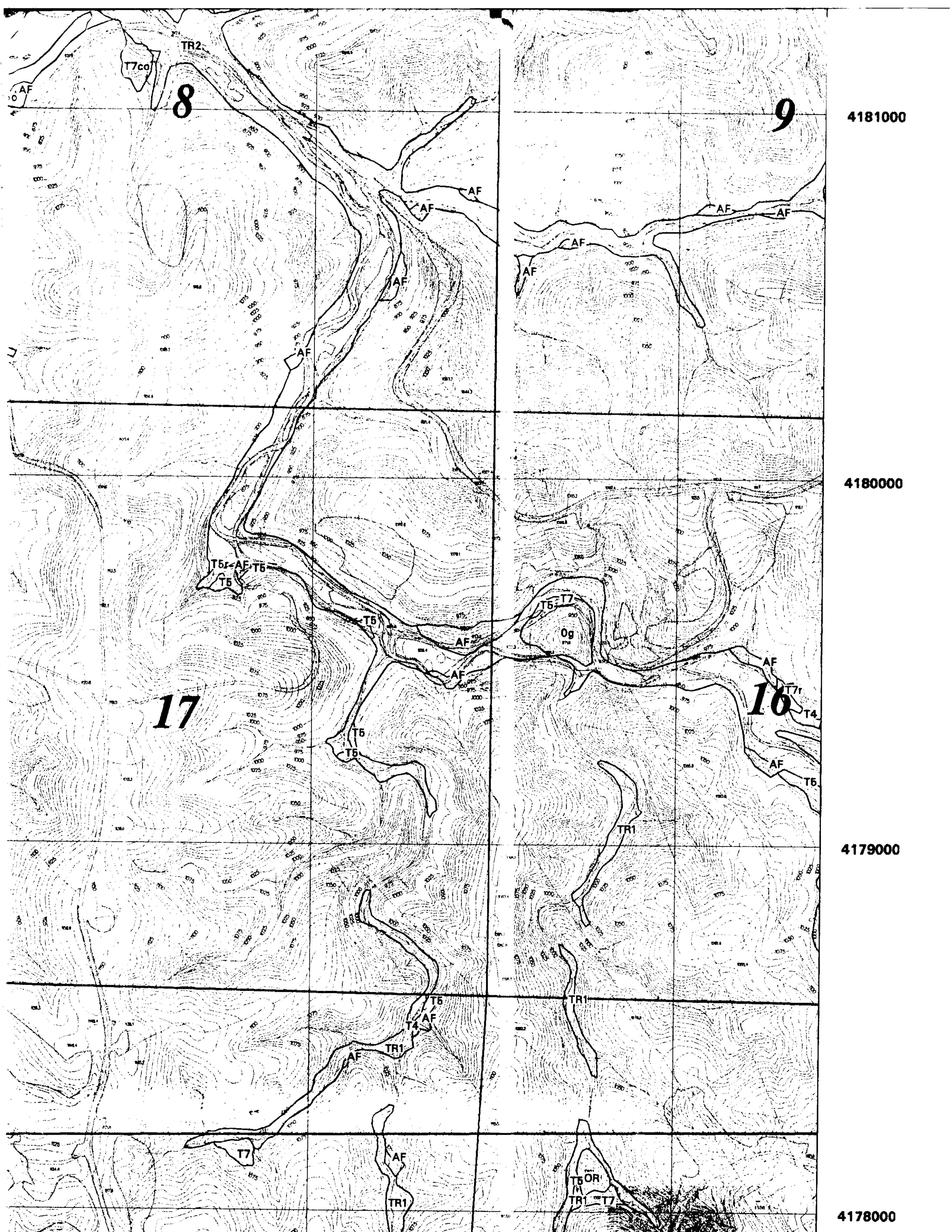
derived from field mapping conducted during this study, Albertson,Meinert, their archaeological potential are contained in the text. The soil-geomorphic ural features and contours, shown as half-tones, were derived from the 1992 napolis, IN, for Fort Leonard Wood in Intergraph Design File format using rojection, Zone 15 using Arcinfo. The UTM grid is in meters. The contour by Information Management Systems, Inc.,Vicksburg, MS in August 1995.

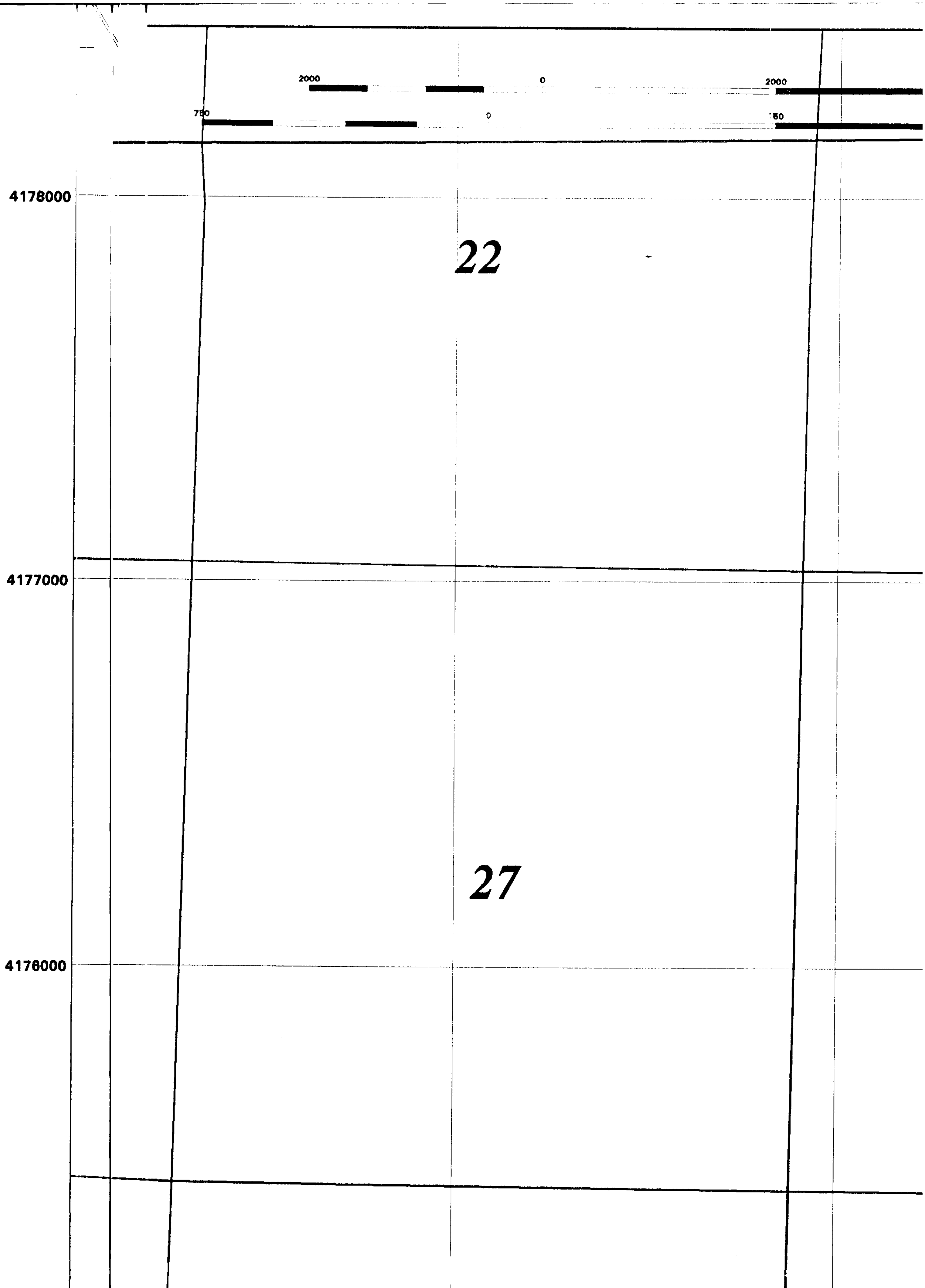


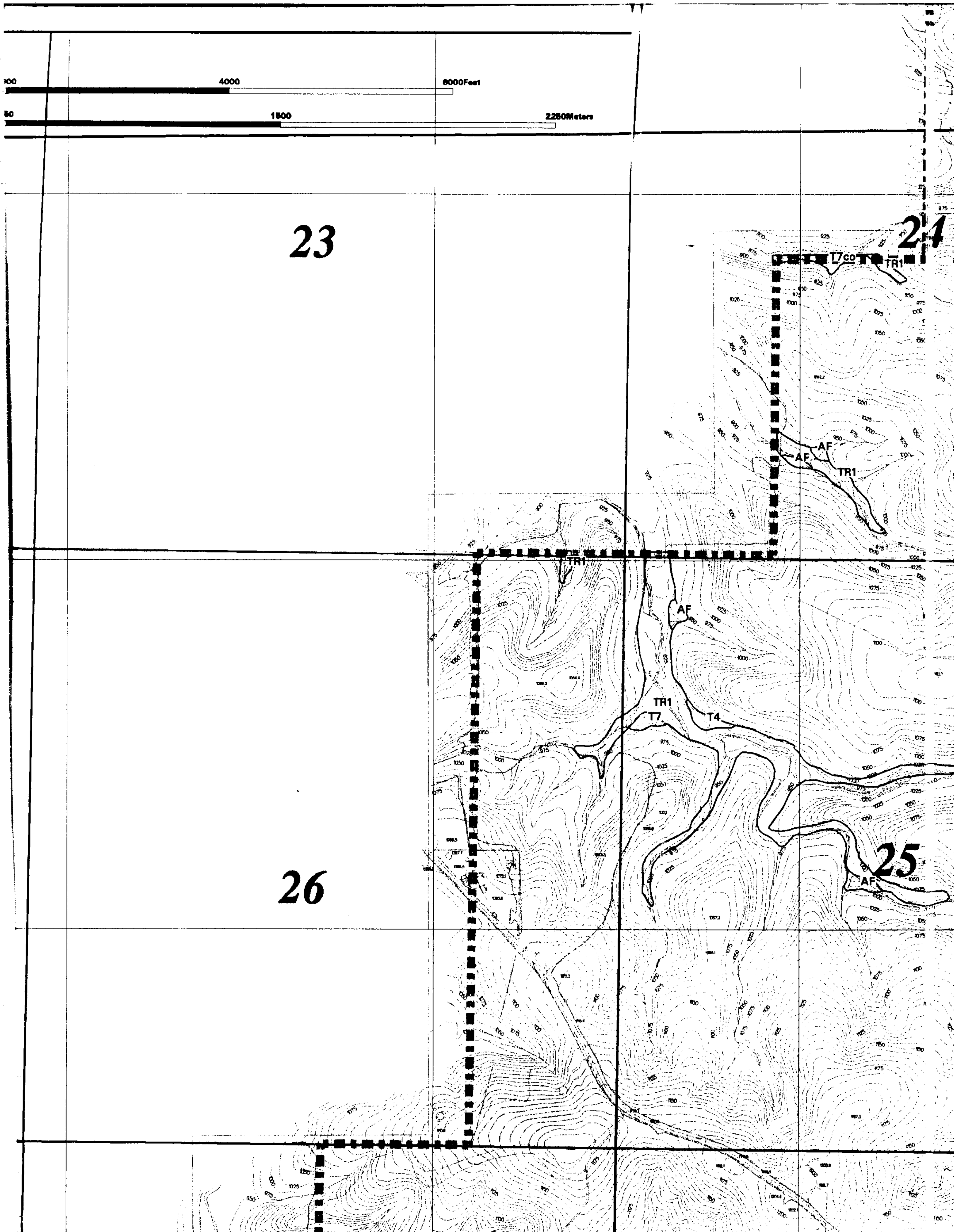

12
7
13
18
T5o
T5
T2s
T1
T2
TR2
T3
T3s
C
AF
T4
T5wo
T5s
TR1s
TR1
T7
T7o
T7co
T1s
TR2s
T4s
T4r
T7r
TR1s

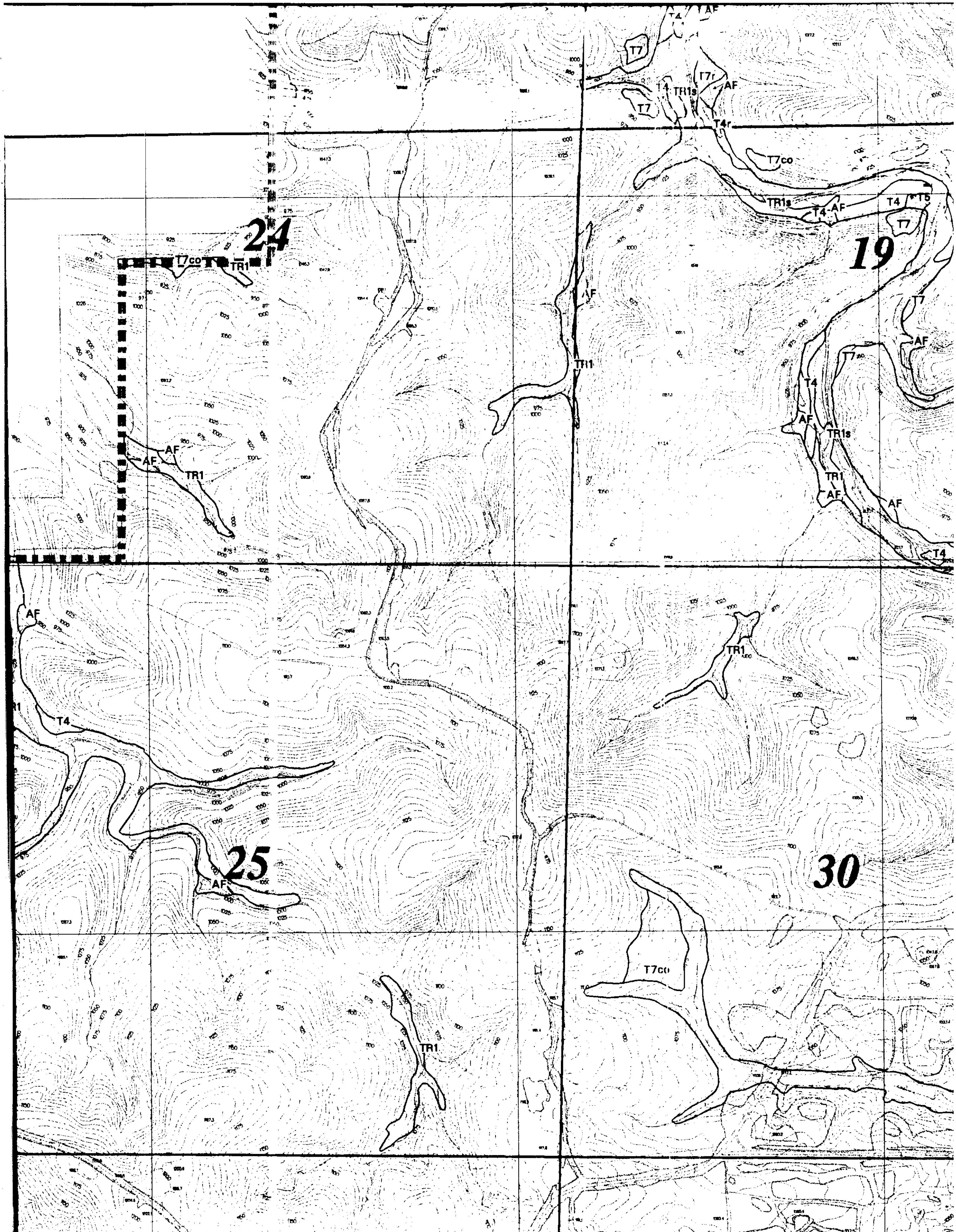


7
8
17
18
T5wo
T2s
T1
T2
T3r
TR2
T7co
T5
T5s
T5o
AF
T4
C
T3
TR1s
TR1
T7
TR2s
T7r
T5r

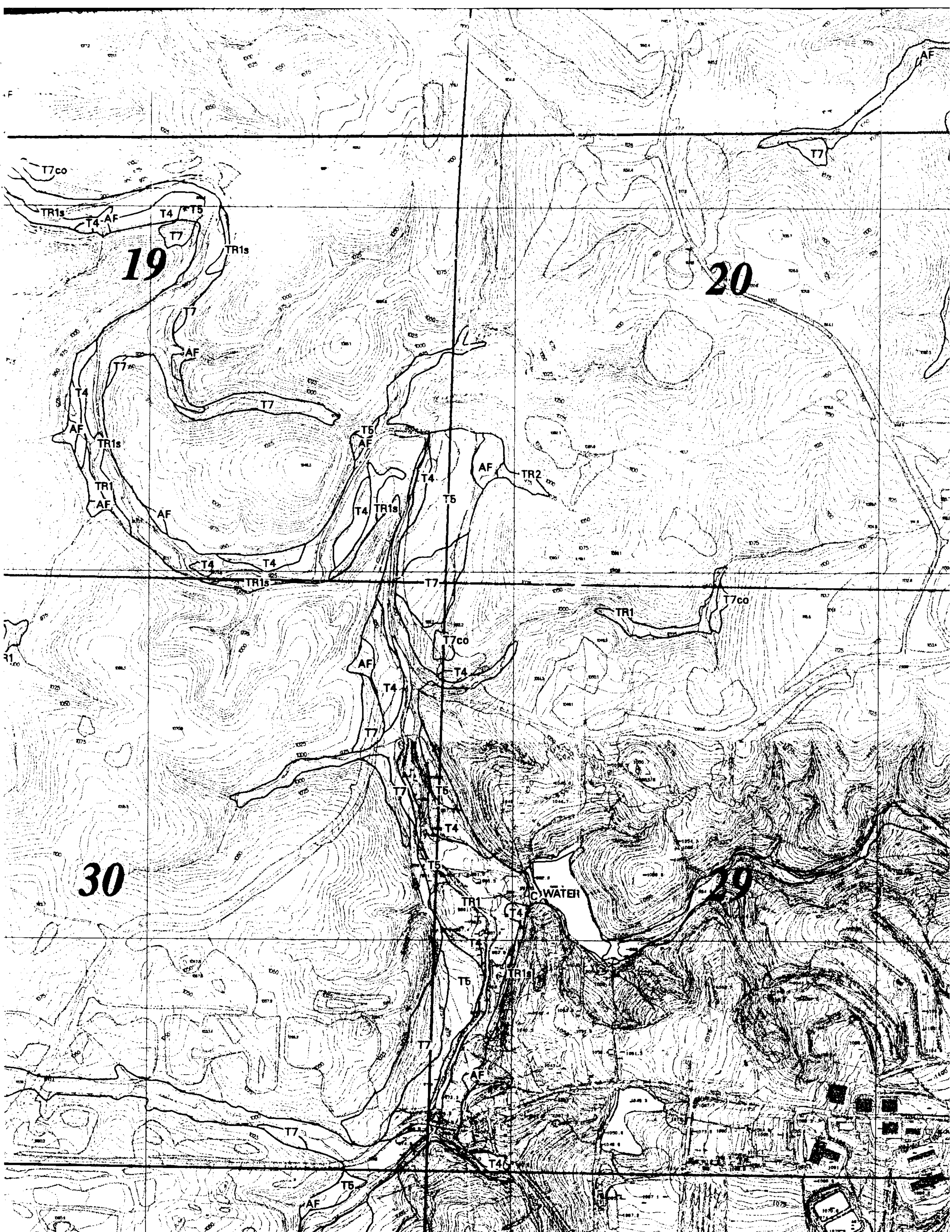

8
9
17
16
4181000
4180000
4179000
4178000
TR2
T7co
AF
T5
T7
T4
T7r
Og
TR1
OR

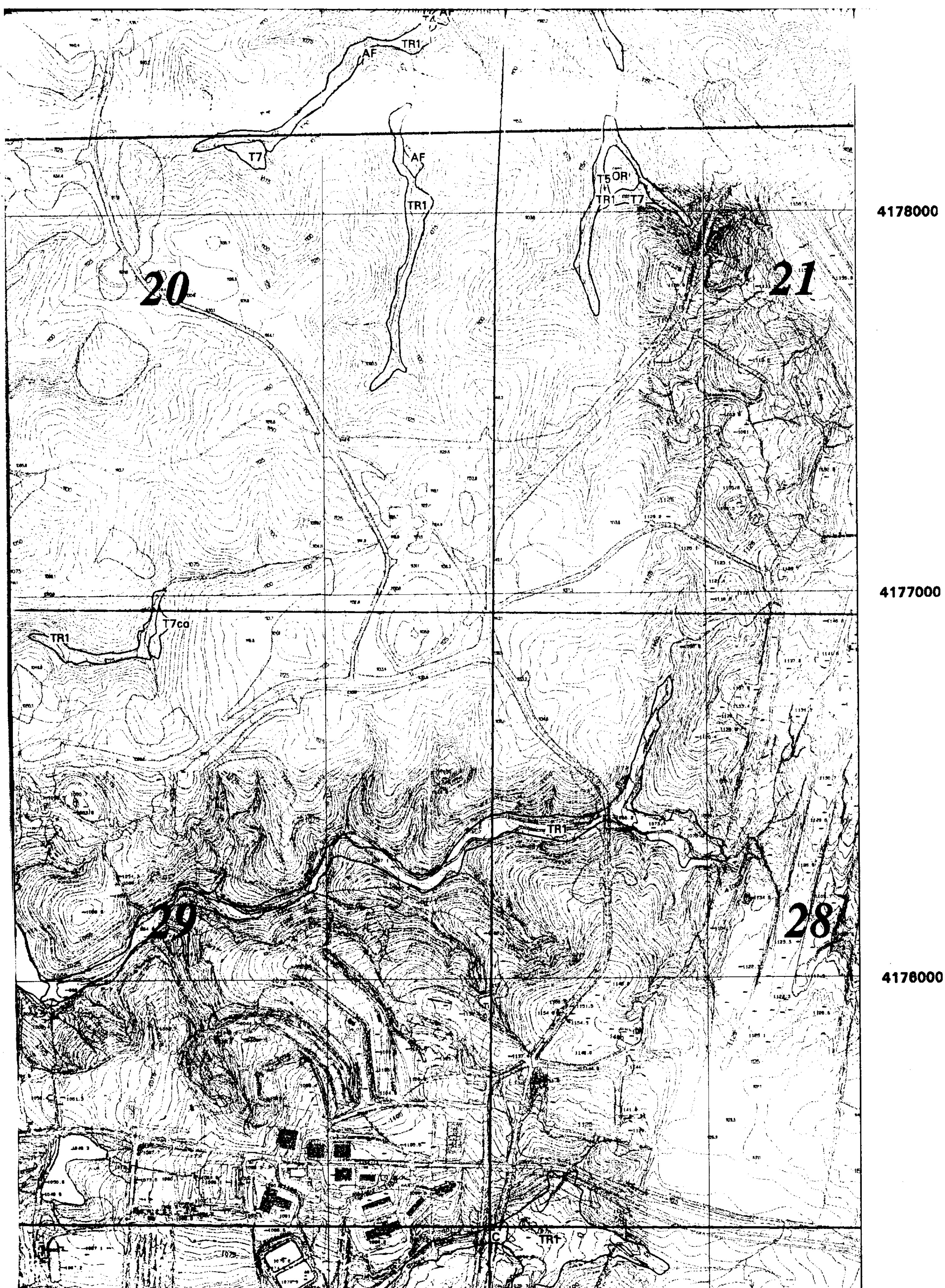

2000
0
2000
750
0
4178000
22
4177000
27
4176000

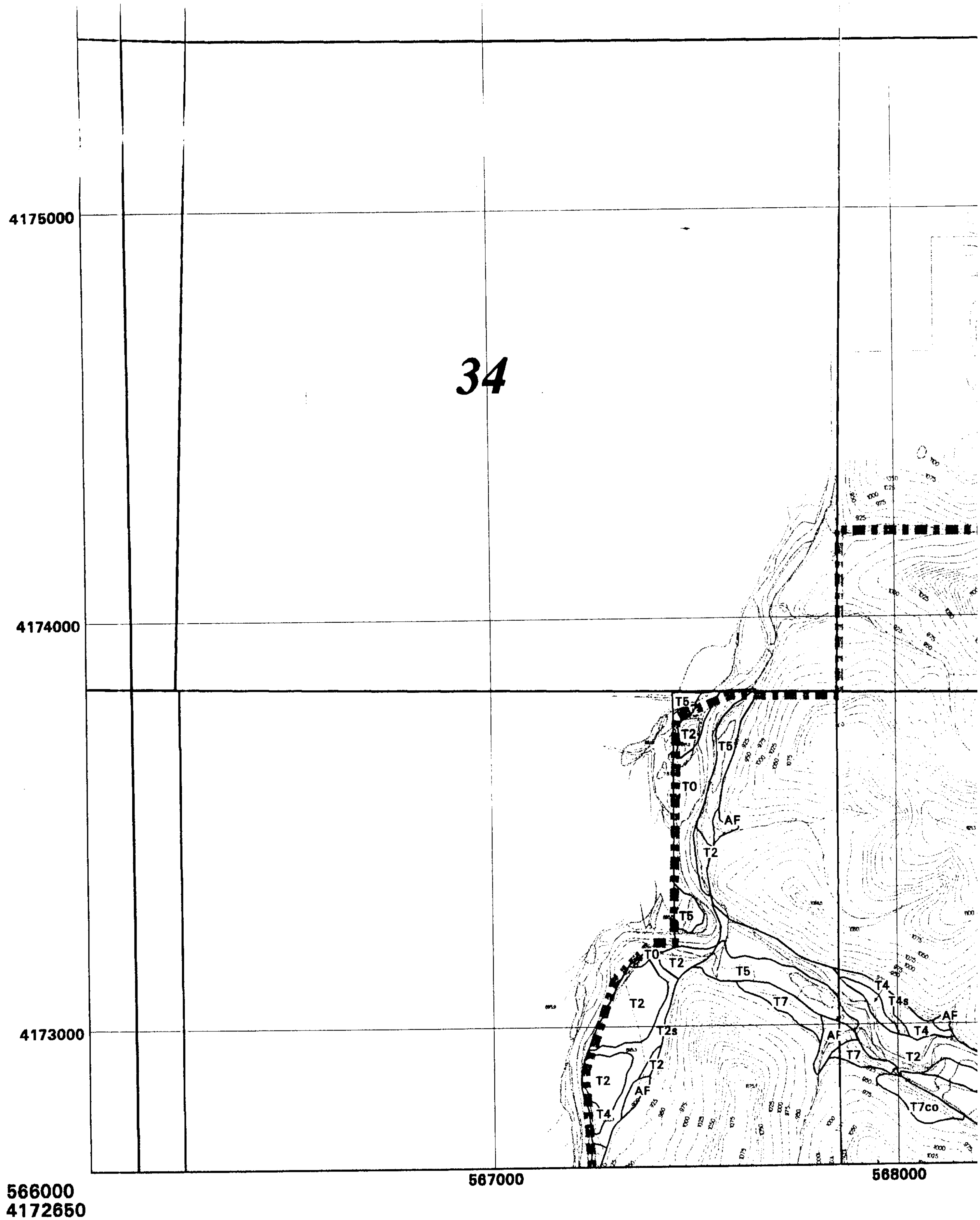

4000
6000Feet
1500
2250Meters
23
24
T7co
TR1
AF
AF
TR1
TR1
AF
TR1
T7
T4
25
AF
26

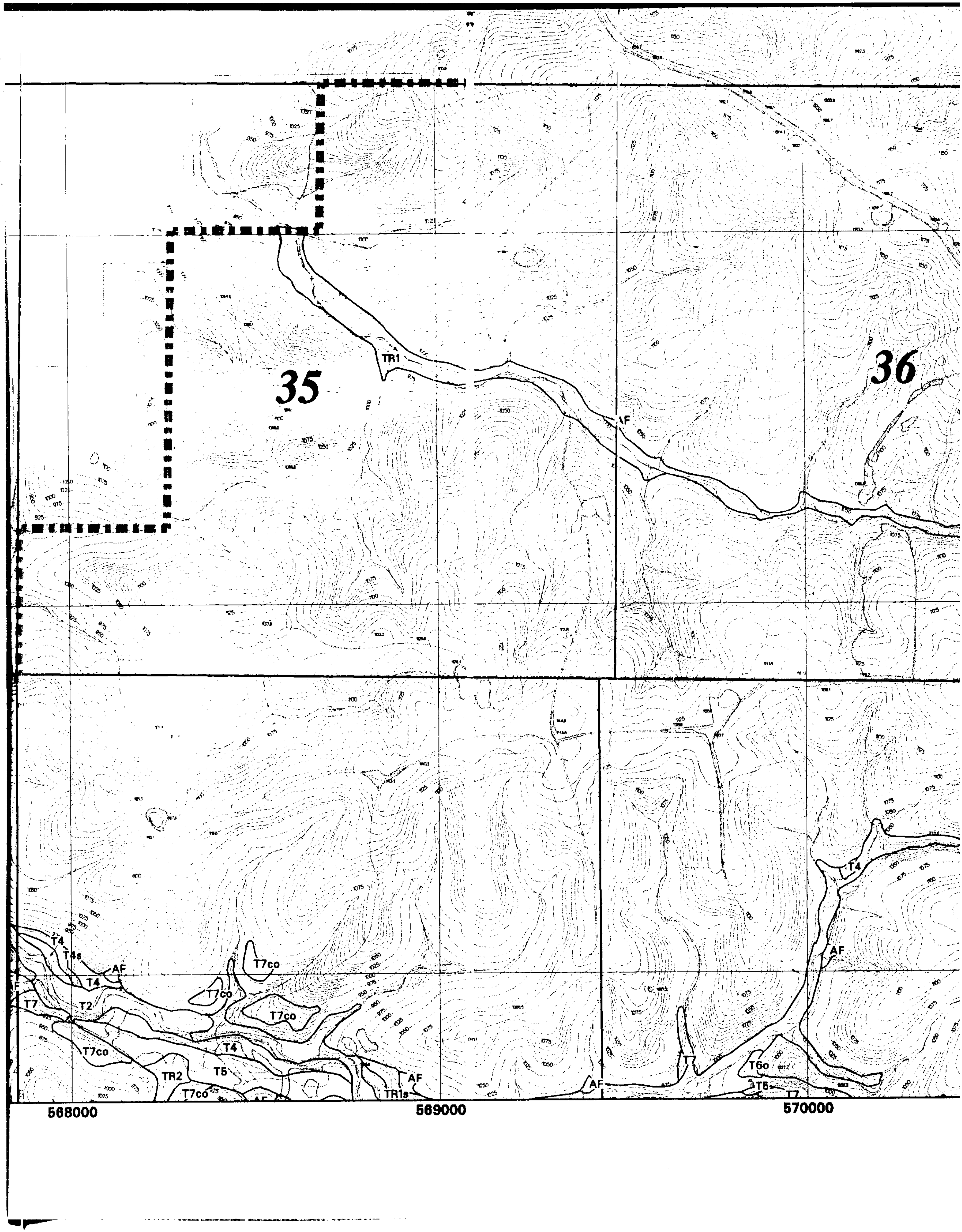


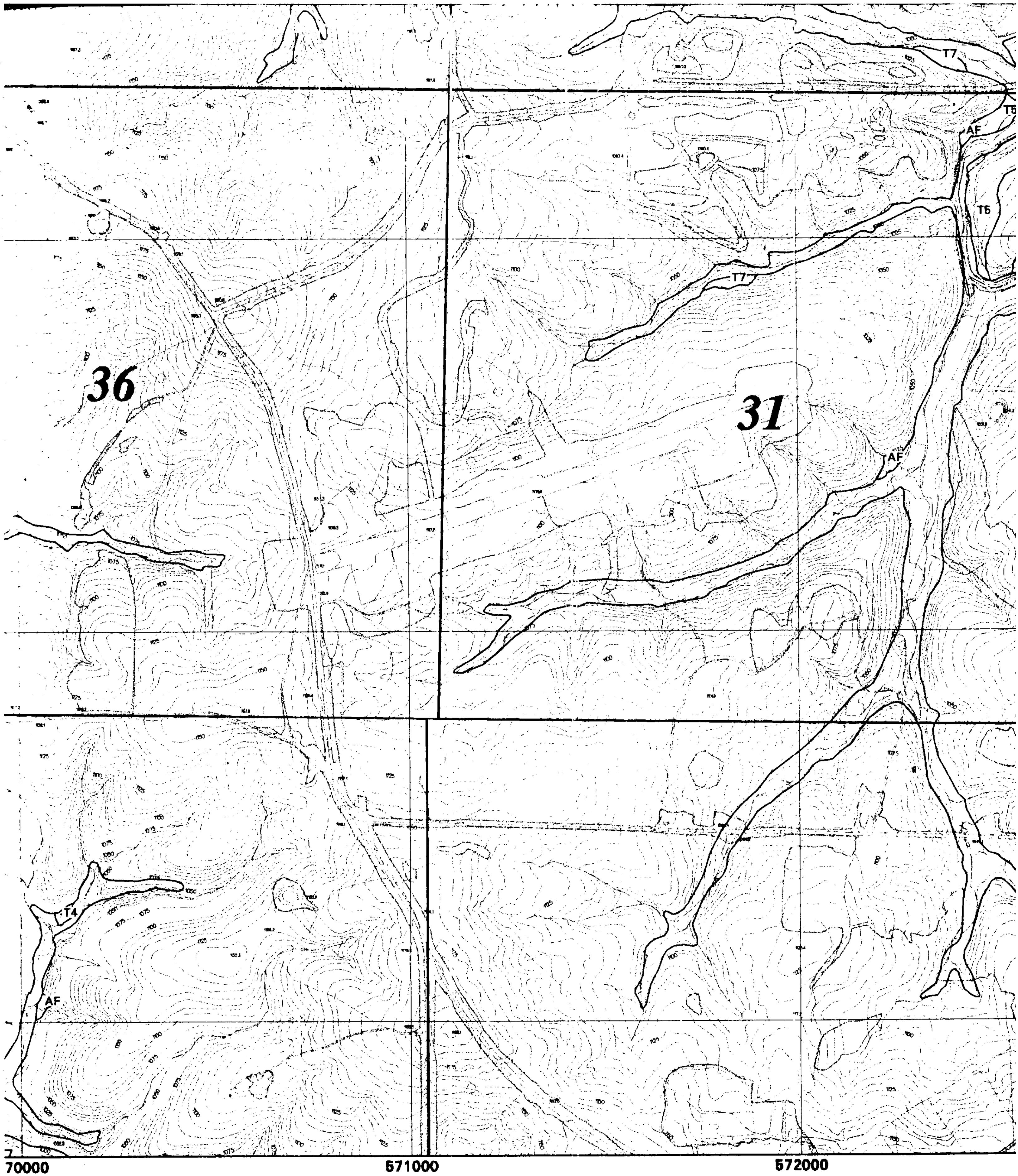
T4
AF
T7
T7r
T4
TR1s
AF
T7
T4r
T7co
TR1s
T4
AF
T4
T5
T7
24
19
T7co
TR1
AF
TR1
T7
AF
T7
T4
AF
TR1s
AF
TR1
TR1
AF
AF
T4
AF
TR1
T4
25
AF
30
T7co
TR1

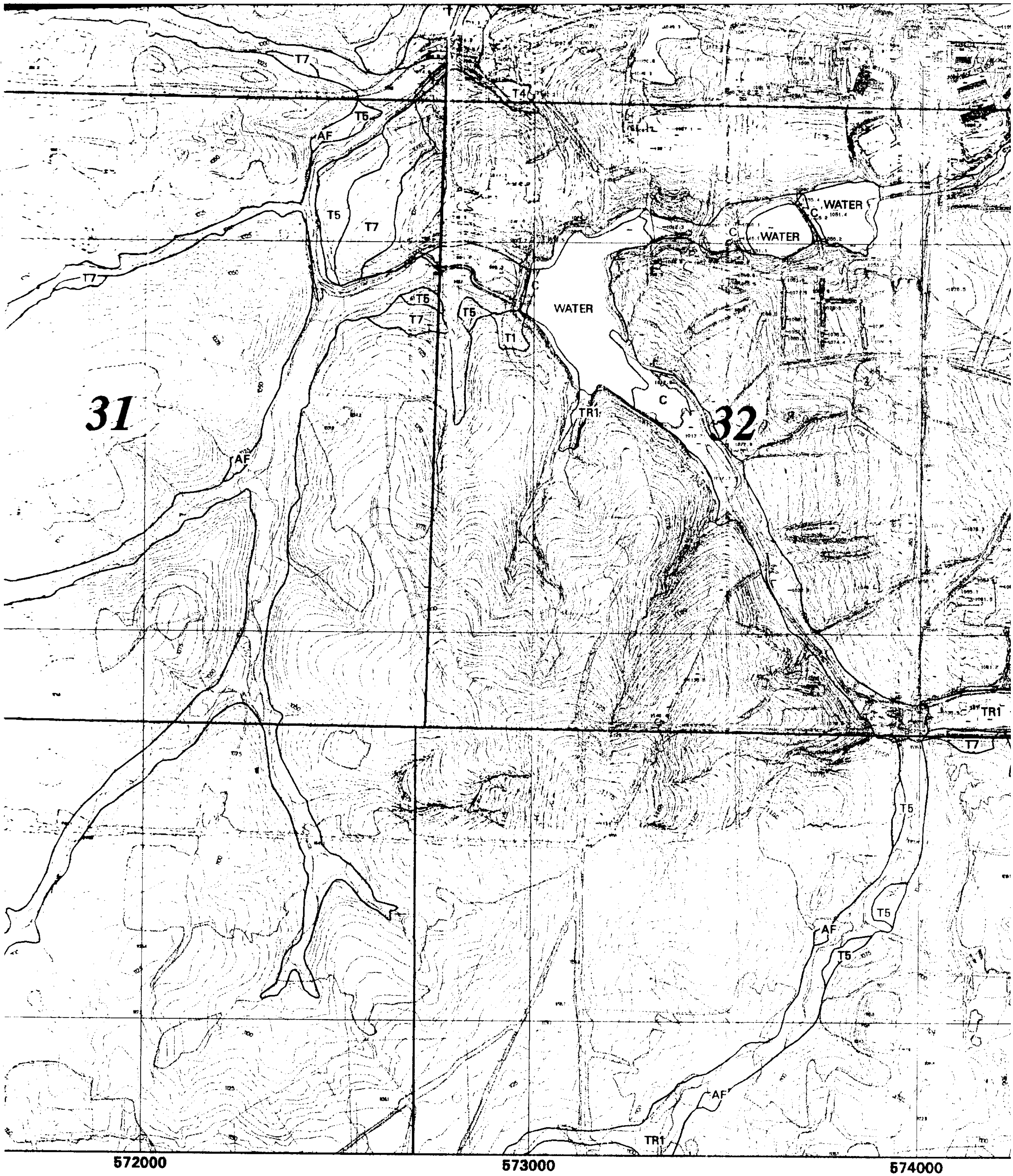

19
20
29
30
T7co
TR1s
T4
AF
T5
T7
TR1
TR2
WATER


AF
TR1
T7
AF
TR1
T5
OR
TR1
T7
20
21
4178000
T7co
TR1
4177000
TR1
29
28
4176000
TR1

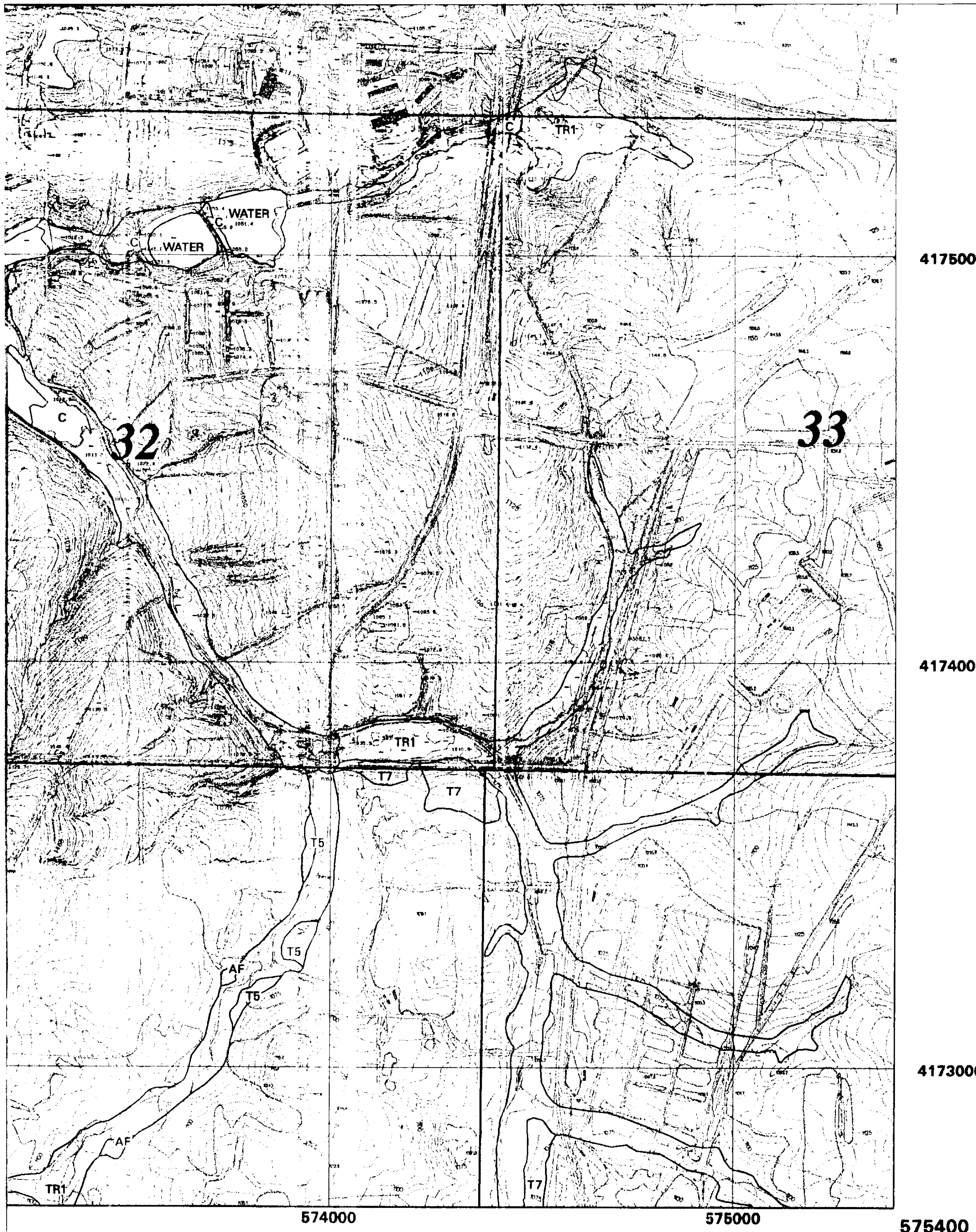

34
4175000
4174000
4173000
566000
4172650
567000
568000
T5
T2
T0
AF
T2s
T4
T4s
T7
T7co


35
36
TR1
AF
T4
T4s
T7
T2
T7co
TR2
T5
TR1s
T6o
568000
569000
570000

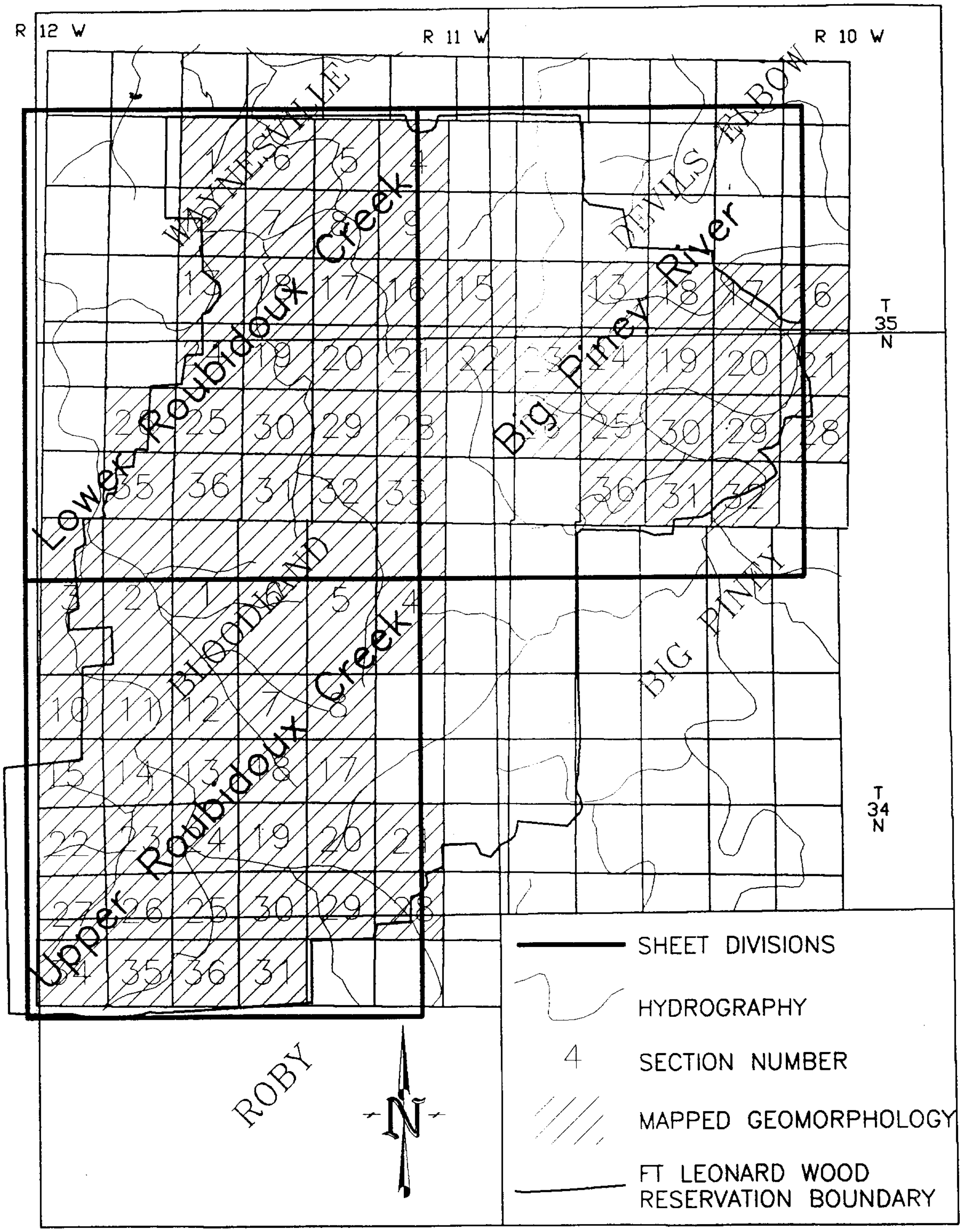

36
31
T7
T6
AF
T5
T7
AF
T4
AF
70000
571000
572000



T7
T4
T5
AF
T5
T7
WATER
C
WATER
C
WATER
T7
T5
T7
T5
T1
WATER
31
TR1
C
32
AF
TR1
T7
T5
T5
AF
T5
AF
TR1
572000
573000
574000



C
TR1
WATER
C
C
WATER
C
32
33
4175000
4174000
TR1
T7
T7
T5
T5
AF
T5
4173000
AF
TR1
T7
574000
575000
575400
4172650



Destroy this report when no longer needed. Do not return it to the originator.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*

2. REPORT DATE
October 1995

3. REPORT TYPE AND DATES COVERED
Final report

4. TITLE AND SUBTITLE
Geomorphic Investigation of Fort Leonard Wood

5. FUNDING NUMBERS
DD Form 448,
No. E5293C044 and
MIPR No. E87930426

6. AUTHOR(S)
Paul E. Albertson, Dennis Meinert, Grant Butler

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road, Vicksburg, MS 39180-6199;
University of Missouri at Columbia, Columbia, MO 65203;
USDA Soil Conservation Service, Columbia, MO 65203

8. PERFORMING ORGANIZATION REPORT NUMBER
Technical Report GL-95-19

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Department of Defense
Washington, DC

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

Soil-geomorphic studies at Fort Leonard Wood, Missouri, provide a Holocene landscape evolution model to predict the potential for archeological sites on the military installation. Results of this research allow for more effective and efficient cultural resource management. The focus of the investigation was on alluvial areas where archeological sites are believed to be buried. The valley bottoms of the Big Piney River and Roubidoux Creek were differentiated at a scale of 1:12,000 into seven soil-geomorphic or allostratigraphic units (T1 through T7). The tributaries were divided into two allostratigraphic units (TR 1 and TR 2). In addition, alluvial fans, colluvial wedges, and strata terraces were recognized. Each allo-unit was discerned based on geomorphic position, lithologic composition, pedological development, and available age dates. A series of radiocarbon analyses associated with T1 through T5 provided chronological control from 215 to 4,630 years, before present (BP). Age estimates for T6 and T7, derived from regional correlation, suggest these older units are Pleistocene in age. T1 was deposited during historic periods and therefore has no potential for prehistoric artifacts in context. T2, with age dates ranging from 200 to 1,400 years BP, has the potential for Late Woodland sites. T3, deposited between 2,000 to 3,000 years BP, may contain buried Middle Woodland sites or younger sites on the surface. T4, with age dates

(Continued)

14. SUBJECT TERMS

Allostratigraphic	Geomorphic
Cultural resource management	Ozarks
Geoarcheologic	Soil

15. NUMBER OF PAGES
380

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED		

13. (Concluded)

ranging from 3,000 to 4,000 years BP, may contain Early Woodland and terminal Archaic sites. Although, radiocarbon dates for T5 only indicate ages between 4,000 to 5,000 years BP, deposition probably began about 8,000 to 10,000 years BP, based on regional correlation. T5 has high potential for buried Early to Middle Archaic sites and surface sites with occupations younger than 4,000 years BP. T6 and T7 have been stable landforms throughout the Holocene. Thus, surface sites of any prehistoric period are possible while buried sites are improbable. In summary, the soil geomorphic mapping with accompanying text and tables offer archaeologists a geochronologic framework to practice sound stewardship of the cultural resources at this Army training facility.